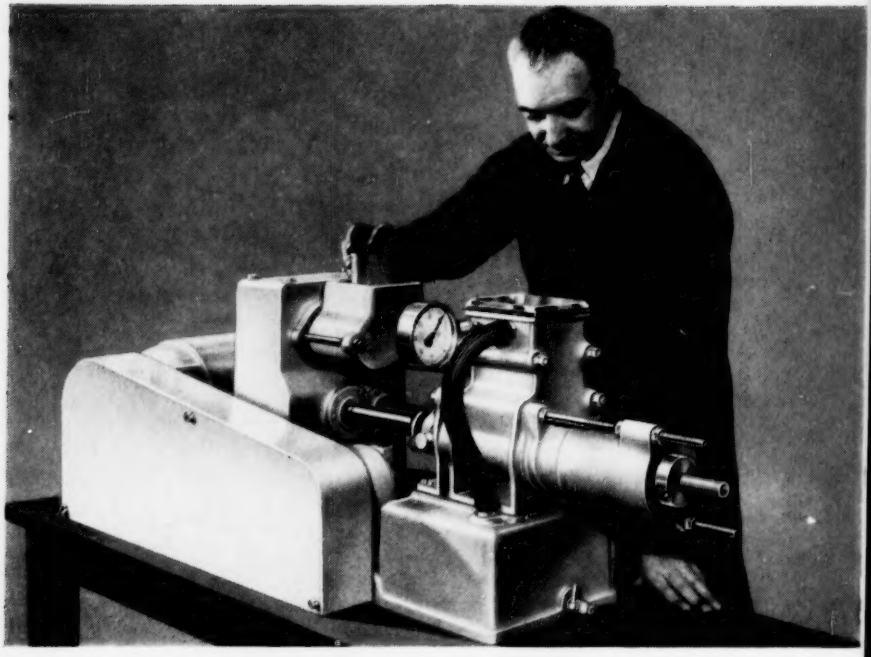
CERAMICS

JANUARY
1955

No. 71 Vol. VI



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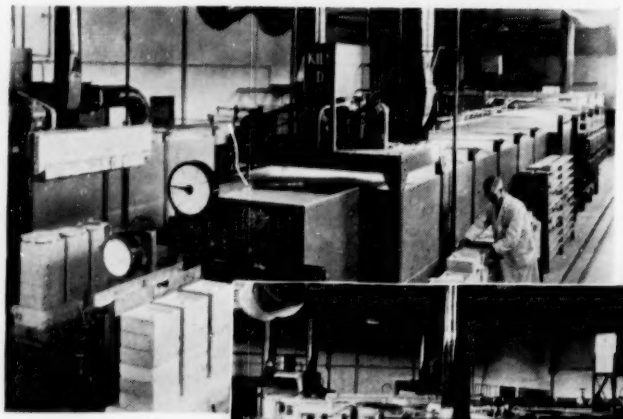

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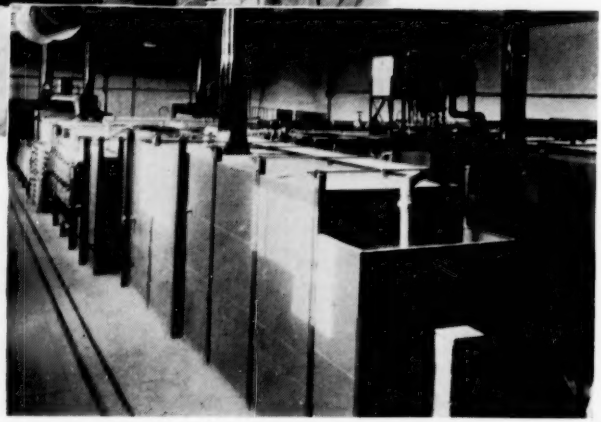

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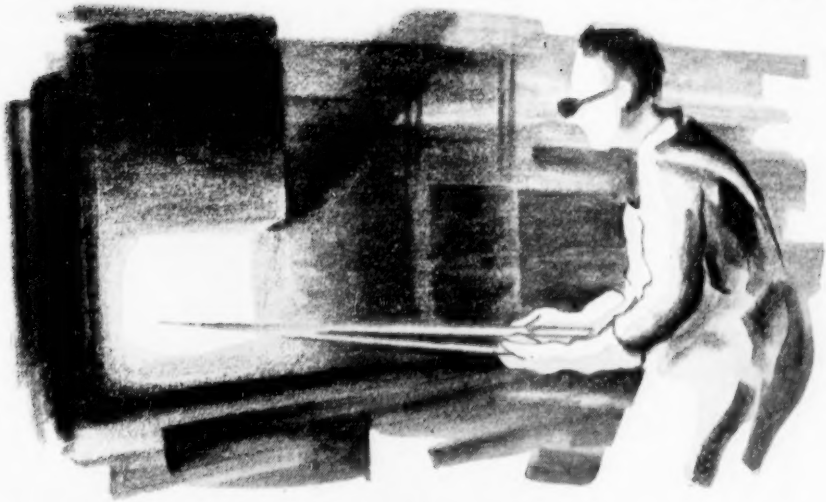

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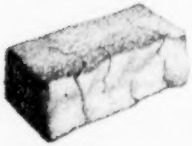

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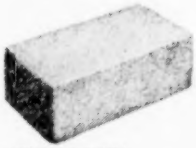

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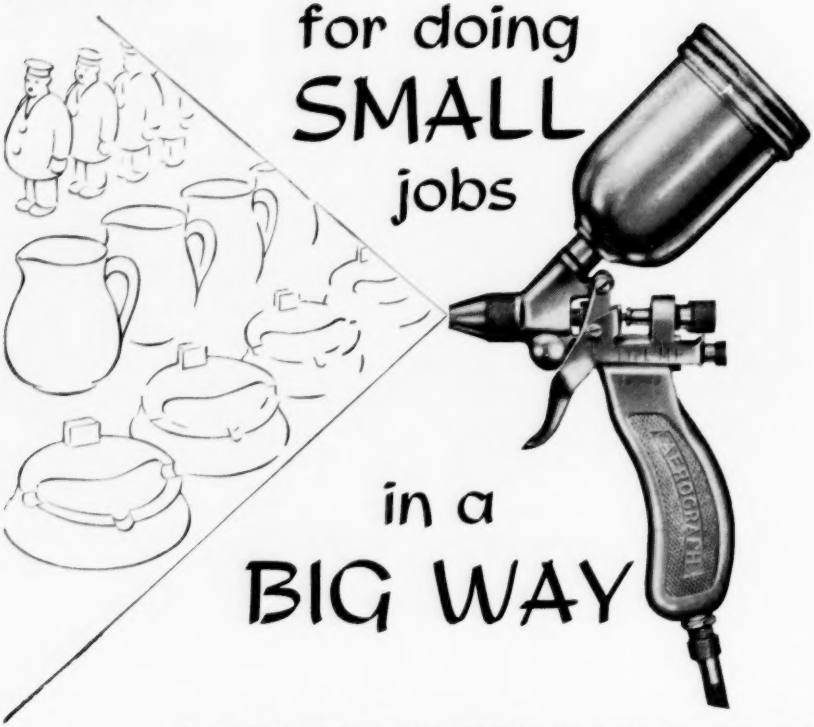

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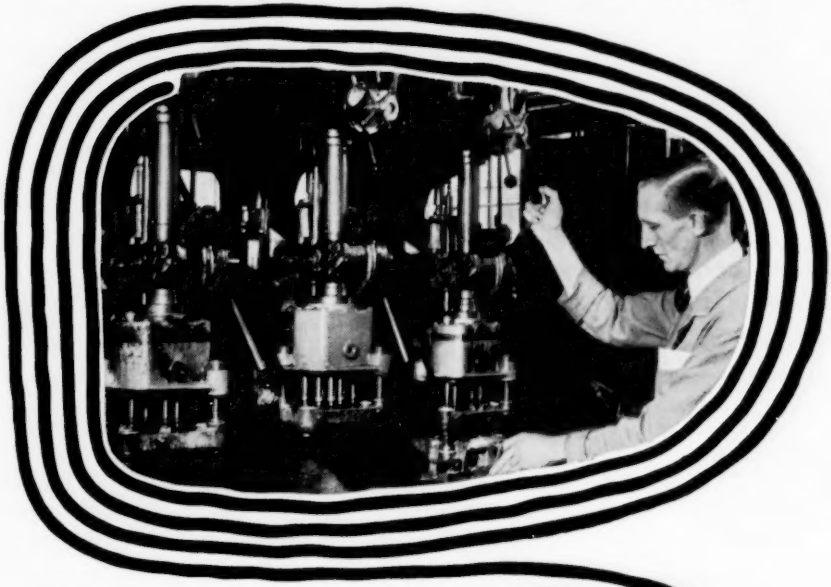

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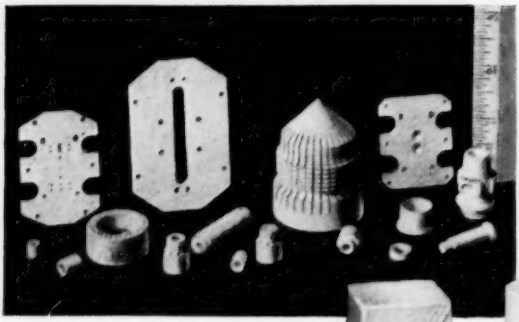

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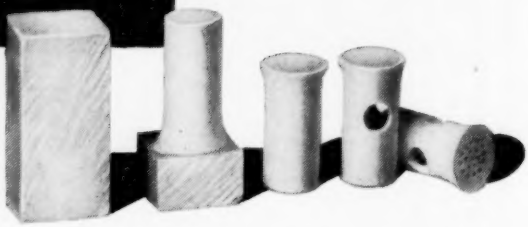

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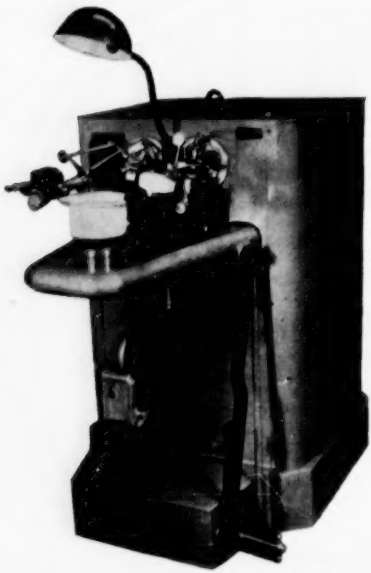

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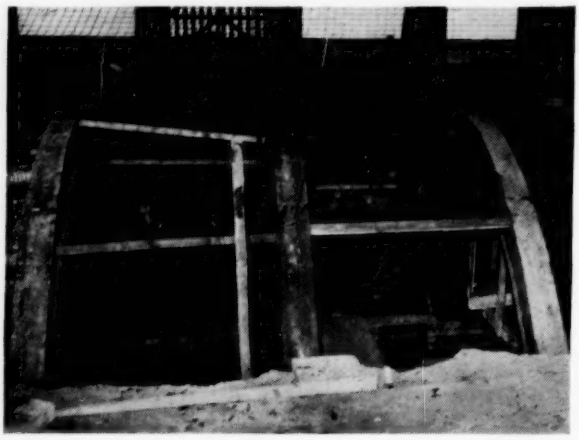

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CERAMICS

A monthly journal covering the pottery, glass, heavy clay, refractory and silicate industries.

JANUARY 1955

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VOL. VI JANUARY, 1955 NO. 71

The Clean Air Bill

ON 4th February a private Clean Air Bill will be presented by Mr. Gerald Nabarro, Conservative M.P. for Kidderminster, who has drawn first place in the recent ballot for Members' Private Bills. It is, of course, based upon the Report on Air Pollution presented by the Beaver Committee and is to be supported by Col. Lancaster, Mr. Maud, Mr. Powell, Sir William Darling and Sir John Barlow on the Government side, with support from the Labour benches by Mr. Noel-Baker, Mr. Robens and Mr. Marquand.

Because it is a Private Members' Bill, Mr. Nabarro has wisely omitted four of the twelve main Beaver recommendations which involve considerable financial assistance from the Exchequer. However, measures will include the prohibition of dark smoke and the empowering of Local Authorities to create smokeless zones, where smoke will be entirely prohibited, and smoke control areas where domestic use of bituminous coal would be restricted. There will be obligations to use efficient grit and dust resisting plant—provisions regulating the design of new industrial furnaces—responsibility of Local Authorities to enforce the law to prevent smoke and grit, with increased penalties for smoke offences. It has been suggested in *The Financial Times* that as the Government's recommendations may take some time to draft, Mr. Nabarro's Bill might be adopted and amendments introduced in Committee.

The implication of all this is, of course, that industry will no longer merely be exhorted to use smokeless fuels and efficient fuel-burning equipment. It will mean that they will be compelled to do so by law.

Since it has already been well established that efficient fuel usage is a paramount necessity in view of our unsatisfactory coal position, and it is also realised by the authorities that fuel efficiency and clean air go hand in hand, industry will have to show more than a passing interest in these subjects, and the arguments that the fuel costs are a small proportion of many industries' total costs, or that people love an open fire, may well be abrogated.

The Bill, if accepted, will also mean that smoke and efficient fuel usage will suddenly become of great importance to the Potteries where the least efficient pottery uses 358 therms per ton of biscuit ware and the most efficient, 17 therms! There is still a lot of smoke over the town.

Refractories for the Steel Industry—II

(SPECIALLY CONTRIBUTED)

The Electric Furnace Process

SPECIAL steels require very careful control of the process and are made in the electric furnace where such control is possible. The heating is done either by using the electric arc, or by induction; the former being more widely used. In the electric arc furnace the current is supplied by three carbon rods (in one very large furnace in America two sets of three carbon electrodes are used to even up the heating). At first the circuit is completed by having the electrodes touching the steel. On withdrawing them somewhat, an arc is established between the electrodes and the steel in which a temperature of around 3,400° C. is generated. The electrodes are about 1 ft. in dia. and pass through the roof of the furnace. They can be raised or lowered as required mechanically. Gradual oxidation of the electrodes occurs and the consumption is about 10-16 lb. of electrode per ton of steel made.

W. M. Farnsworth and E. R. Johnson (*J. Iron Steel Ind.* **138,** (11), 289, 1938) give the following details of some American arc furnaces:

For a 10-ton capacity furnace the charge is melted in about 2 hours and the refining which follows taking another 3½ hours. The linings can be of the acid or basic type, though the latter are more common. The acid process uses an acid slag and consequently it will not remove phosphorus and sulphur. Removal of carbon is also more difficult. It is mainly used for making steel for castings. For the acid process the furnace lining is silica brick in the side walls and roof, while the hearth is built up of sand or ganister as in the acid open hearth process. The basic furnace is of relatively simple construction compared with the basic open hearth furnace, since there is no flow of gases to be dealt with. It may be divided into walls, roof, and hearth. The 10-ton capacity size may have an approximate internal diameter of about 9 ft. while the height to the roof is about half that. The hearth for this size is about 2 ft. deep. A table of principal dimensions of electric arc furnaces is given on page 191 of *Manual of A.S.T.M. Standards on Refractory Materials* (Amer. Soc. Testing Materials, Pa., 1952). The largest electric furnace given in this list has a capacity of 100 tons. The hearth of this has inside dimensions 17 ft. × 26 ft. (elliptical). The bath depth is 34 in. The inside dimensions of the steel shell are such as to allow for about 3 ft. thickness of brickwork. Six carbon electrodes are fitted in two groups of three each to carry the current.

TABLE I.

Furnace capacity (tons)	*Transformer capacity kV.A.*	*Voltages*			*Graphite electrode dia. (in.)*	*Hearth area (sq. ft.)*
		High	*Int.*	*Low*		
25	10,000	240	180	115	18	100
15	4,500	220	170	110	14	64
6	2,800	180	—	110	12	40

The Hearth

The high temperature, 1,450-1,700° C., and the severe slagging action means that the basic hearth and side walls have to be made in similar materials to those specified for the basic open hearth furnace. According to Dr. J. H. Chesters (*Steelplant Refractories*, Sheffield, 1944), there are now a variety of ways of building up the hearth ranging from ramming the dolomite on the steel pan itself and sintering it in position by the heat of the process, to the more usual practice of building up 9-12 in. of bricks under the monolithic hearth. The brickwork is again made up of variations of insulating brick next to the steel shell, followed by firebrick and then two layers of magnesite brick, or combinations in which the insulating brick is omitted, and a layer of firebrick placed next to the shell and three courses of magnesite brick or dolomite brick built on it. The courses of bricks are staggered to make it more difficult for metal to penetrate. The properties of the bricks are similar to those detailed for the open hearth. The monolithic hearth in this country is made of tarred Basic (calcined dolomite), which is rammed in layers, each being burnt in by covering with coke and turning on the current to heat it for 36 hours. The total thickness is 9-12 in. In other countries dead burnt magnesite is used, and sintered in layers by heating with the electric arc.

Farnsworth and Johnson (*loc cit.*) give the following details for one American plant. The mix is 80 per cent. graded periclase grain, and 20 per cent. of finely ground Austrian magnesite. Sodium silicate is added to this as a binder. The grading of the mix is:

20 per cent. $\frac{1}{2}$-$\frac{1}{4}$ in. mesh periclase grains, 90 per cent. MgO.
20 per cent. $\frac{1}{4}$-$\frac{1}{8}$ in. mesh periclase grains, 90 per cent. MgO.
40 per cent. $\frac{1}{8}$ to fines periclase grains, 90 per cent. MgO.
20 per cent $\frac{1}{16}$ in. mesh to fines dead burnt Austrian magnesite 83 per cent. MgO.

To this is added just over 5 quarts of

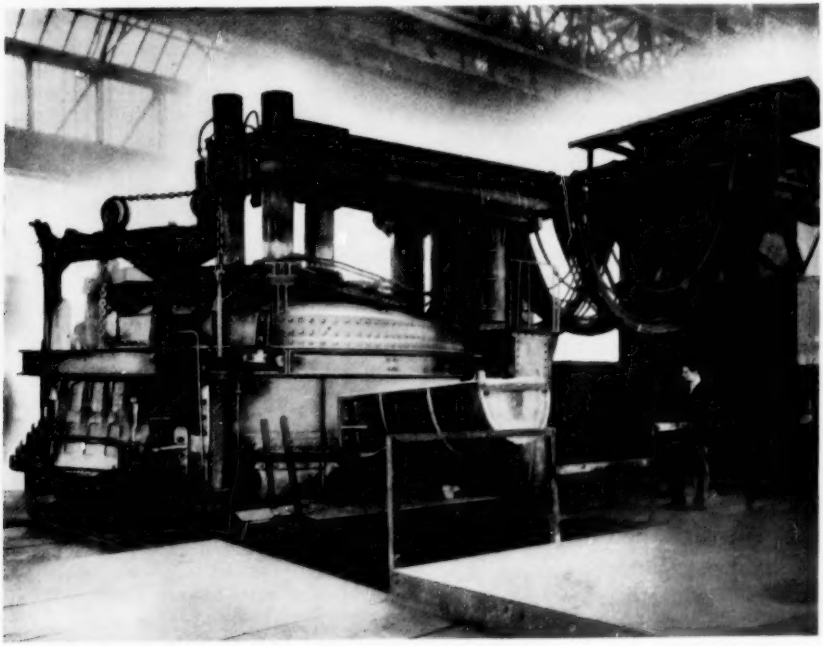


Fig. 1. Electric Arc Furnace
(Photo by courtesy of British Iron and Steel Federation)

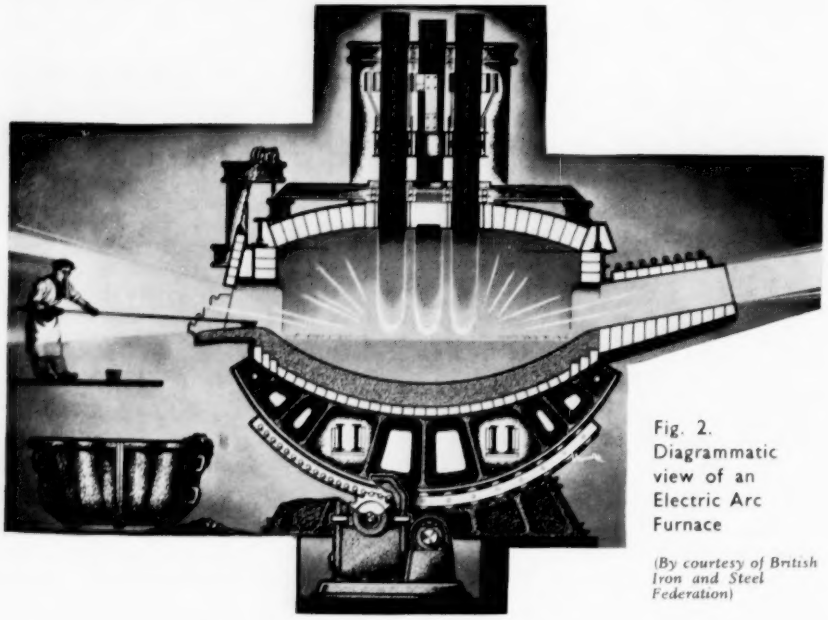


Fig. 2. Diagrammatic view of an Electric Arc Furnace

(By courtesy of British Iron and Steel Federation)

liquid silicate of soda per hundredweight to give a good plastic ramming mixture. It is rammed in layers 2-3 in. thick at a time until of the required thickness and shape. After this it is dried for a day with a wood fire, and then the arc turned on and the temperature raised to just below that required to make the silica brick in the roof drip. After 24 hours about 3-5 in. depth is sintered, and the furnace can be put to work. A life of about six months may be expected for a basic hearth (600-1,000 melts).

Side Walls

The side walls are either made of bricks or of a rammed monolithic structure, the former being more common. The slagging conditions are severe and the materials for construction are similar to those of the basic open hearth side walls. A 10-ton furnace may have walls 18 in. thick—the outer one being 4½ in. thick of fireclay. The inner courses can be magnesite, chrome-magnesite or stabilised dolomite bricks. These are of similar qualities to those detailed for the open hearth process (see previous issue). According to Dr. Chesters (*op. cit.*) semi-stabilised dolomite bricks are finding increasing use. They have good thermal shock resistance and a higher resistance to slag than fully stabilised dolomite. A top course of chrome-magnesite is put in to protect these bricks from drips from the silica roof. The tapping arch is made of magnesite bricks, while silica brick is used for the charging arch because of its high refractoriness under load. Under normal working conditions the life of the side walls in a 10-ton furnace is three to four weeks or 75-100 heats.

Chrome-magnesite seems to give a somewhat longer life. The reason for failure with basic bricks is spalling, the cause of which is still somewhat obscure.

The Roof

Electric furnace melting imposes severe conditions on the roof, which has to withstand the action of flux-laden gases and the high temperature (1,450-1,700° C.) generated by radiation from the arcs. Most roofs are made of silica bricks. These need to be of low porosity and good shape to resist erosion.

One well-known type has the following characteristics:

Typical Analysis

	per cent.
Silica	95·87
Titania	0·23
Alumina	0·95
Ferric oxide ...	0·76
Magnesia	0·03
Lime	1·71
Alkalis	0·34

Refractoriness: Cone 33 (1,730°C.)

Refractoriness under load (50 p.s.i.)

Initial deformation 1,650° C.

10 per cent. subsidence 1,690° C.

Specific gravity: 2·32-2·33.

After expansion: (2 hours at 1,450° C.) 0·2 per cent.

Apparent porosity: 18 per cent.

Sillimanite has been used in roofs on small furnaces and gives better results. It is of low thermal expansion and high thermal shock resistance. Its higher cost compared with silica bricks has prevented the wider use of sillimanite to date. Other materials of high refractoriness have been used, but again the cost is not justified at present except possibly for very special applications.

The roof is either domed or flat on top (Figs. 3 and 4). The average thickness is 12 in. Larger types are often constructed with ribs which improve strength. Allowance is made for expansion on heating in the construction. Failure of the roof appears due to the action of vapour and dust on the silica. It must be remembered that lime is used for fluxing and the arc is bound to disperse some of this into the furnace atmosphere. Spalling may occur if the furnace is heated up or cooled too rapidly. Care is needed in this connection with furnaces with roofs that can be lifted off. According to Dr. Chesters the life may vary from thirty to forty heats in some plants to 100-200 in others. The life varies with the plant conditions, whether the metal is charged hot or cold, or whether the refining period is short or long. The brick rings, through which the electrodes pass, are often worn away quickly by hot gases. Local repairs to these are done to lengthen the roof life.

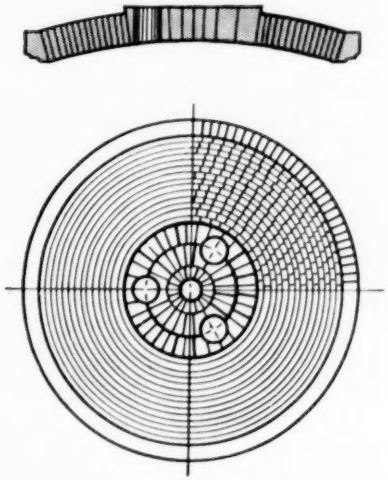


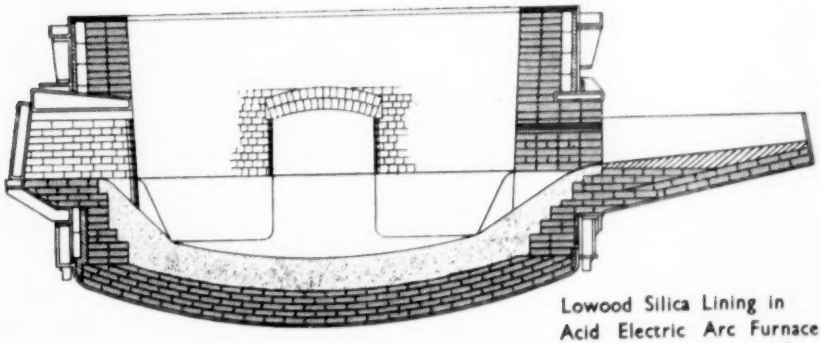
Fig. 3. (Left) Arrangement of roof for 10-ton Electric Arc Furnace

Fig. 4. (Below)

(Diagrams by courtesy of General Refractories Ltd.)

Door, Taphole and Spouts

The door is usually lined with an alumina (35-38 per cent.) fireclay brick. This should melt at about 1,170° C. Two types of tap hole are



Lowood Silica Lining in Acid Electric Arc Furnace

in use. In the first it is built just above the slag line. In this is placed a refractory clay tile (P.C.E. 27-30). This does not last long and is replaced as required during recharging operations. In the second type the tap hole is below the slag line and the latter cannot be discharged until the steel has run off. This is normally sealed with an iron pipe packed with refractory material and is dug out for pouring. The spout is lined with a variety of materials such as ladle brick and magnesite, chrome or fireclay brick. As an alternative it may be lined with the same material as for the monolithic layer in the furnace. Whichever material is used it must be able to withstand the high temperatures noted above and severe slagging action, coupled with thermal shock.

The Induction Furnace

Most schoolboys are familiar with the fact that if a piece of wire is surrounded by a wire coil in which an electric current is flowing, an induced current is generated in the wire. This fact is used in the induction furnace. A primary current of high frequency is made to flow in a coil wound round the outer side of the furnace and the metal charge takes the place of the wire in the example given above. The induced current in the metal is dissipated as heat which melts the charge. In addition the current set up gives very good stirring of the molten metal. Current frequencies used vary with the size of the furnace. Large units may employ frequencies of 900-2,000 cycles while small ones have been known to use a frequency of 20,000 cycles. Due to the rapid melting the output can be as high as in a larger arc furnace and there is no danger of pick up of carbon from electrodes. The cost of making steel is higher, however, by the induction furnace method.

Although the heating can be strictly controlled and in some ways the wear and tear on refractories is not as severe as in some other steel-making processes, there are certain peculiar features of the induction furnace which present problems which are still not completely solved. The most pressing is the problem of making metal tight refractory linings for the basic process which will last longer than they do at present. Break-outs of metal are always dangerous.

While it is possible to use considerable thicknesses of refractory materials in the hearths of blast and open hearth furnaces this cannot be done in the induction furnace. To secure efficient melting of the metal the thickness of refractory between the metal and the outside coil is only a few inches and any metal which does penetrate the lining is kept hot by induction. The outside is normally water-cooled and although this tends to solidify molten metal it also increases the danger of explosions if the molten metal reaches the water. In addition, short circuits add to the dangers. While there seems little difficulty in making metal-tight linings for the acid process, the basic process offers considerable difficulties in this respect even on small installations (cf. J. H. Chesters, L. Lees and J. Mackenzie, *Trans. Brit Cer. Soc.*, **48,** 263, 1948-9).

Construction

The furnace construction is relatively simple. The outer shell is cylindrical and the height of the metal bath is about equal to the diameter. It is poured by tilting and running-off the metal at the nose as one pours liquid from a cup. Nowadays there are induction furnaces ranging from a few pounds to between 7 and 8 tons capacity. The bigger sizes are normally operated on the acid process. The melting time varies from a few minutes to about 3 hours.

The outer shell is surrounded by a water-cooled coil carrying the primary high-frequency current. The refractory lining may be a prefired crucible in the smaller sizes, or a monolithic shell in the larger ones. Brick linings are another development. Crucible linings are made from fireclay, magnesite, magnesite-zircon and plumbago. The latter gives a long life but also gives the danger of carbon pick up by the metal. Attempts to avoid this by coating the crucible with a refractory paste have not been completely successful due to cracking.

The space between the crucible and coil is packed with zircon sand. The life of the crucible is short—about five melts being the limit.

Monolithic Linings

Most of the furnaces are, therefore, rammed with a monolithic lining. This is tamped around a former which is made of steel or asbestos. Most British furnaces employ the former material. Either basic or acidic linings are made in this way. The bottom of the coil is bricked over with silica or fireclay brick for the acid process and with magnesite or fireclay for the basic lining. Granular refractory is then poured in to a depth of about 6 in. and thoroughly rammed home. The steel liner, which is cylindrical in form, is then placed in position with the help of wood spacing pieces. Dry refractory is then run in and rammed down in increments of 2-3 in. depth at a time. The spacers are, of course, removed when required and the holes filled up and rammed well down. The ramming may be done dry or with the addition of binders such as clay, soda silicate or boric acid. When within a few inches of the top the lining is finished off with special cement, or by adding sodium silicate to the mixture. Scrap is then charged and the current switched on. This results in eventually melting the liner and the refractory is sintered together.

Asbestos formers when used are treated similarly. During the first heating the asbestos forms a slag which rises to the surface.

Magnesite is commonly used, but other materials which have been used are mixtures of 70 per cent. of fused magnesia with 30 per cent. of fused alumina (with a clay binder) and zircon.

Dr. J. H. Chesters and his co-workers (*loc. cit.*) mention the following mixtures which are used commercially:

(a) Graded sea water magnesia with sand and borax.
(b) Graded magnesite-chrome mixture using sea water magnesia.
(c) Bonded mixture of graded sea water magnesia and alumina.

These have been limited to furnaces up to 2 tons capacity.

Grading Important

It is important that the lining should sinter to a uniform, dense, impermeable structure, through which metal will not penetrate. Shrinkages in services may lead to cracking with rapid penetration of metal. The same authors recommend that the magnesite used should be completely dead burnt to avoid excessive shrinkage, since their experiments have shown that soft-burned material gave relatively high shrinkage and a poor service life. The magnesia content should be as high as possible. The iron content affects the degree of sintering of the magnesite, being greater with the higher iron content. Satisfactory results have been obtained with lime contents varying from 2-6 per cent. There must not be free lime present, since this would hydrate with swelling. Similarly, the dead-burnt magnesite should not tend to hydrate, and should be dense and have a low porosity.

In order that this may be rammed to a dense monolith the grading is important. If the material is too coarse it does not sinter properly, if too fine it is difficult to ram and may give excessive shrinkage. For the sea water magnesia with sand and borax additions the properties of the lining were given by Chesters and co-workers (*loc. cit.*) as:

Chemical analysis	*per cent.*	*B.S. grading sieves*	*per cent.*
SiO_2 ...	7·5	On 7 mesh ...	15
Al_2O_3 ...	1·9	7-22 mesh ...	35
Fe_2O_3 ...	1·7	22-72 mesh ...	16
CaO ...	3·1	72-150 mesh ...	10
MgO ...	83·1	Through 150 ...	24
Loss on ignition ...	1·1		

The same workers emphasise the need to promote a permanent expansion at intermediate temperatures to prevent metal penetration. They therefore studied the expansion and other characteristics of mixtures containing sea water magnesia with the aim of producing this desirable property. The most satisfactory results were obtained with sea water magnesia to which was added 4 per cent. of sand and 2 per cent of borax. This gave a permanent expansion of 1·5-2·0 per cent at 1,150° C. These gave excellent results on the works. For full details the original paper should be consulted. This work is a definite step forward. The aim is now to extend it to further improve the life of the linings and to apply the

method to larger furnaces. The average life of present basic furnaces is about a week.

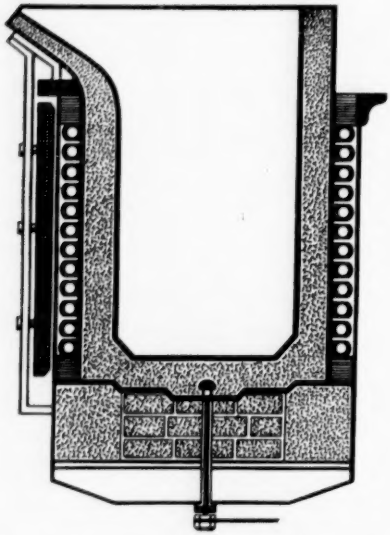


Fig. 5. Diagrammatic view of a high-frequency induction furnace

(By courtesy of British Iron and Steel Federation)

Acid Linings

The making of monolithic linings for the acid process is similar to that outlined above. The material used is commonly crushed quartzite or ganister (precalcined or raw) with additions of about 1 per cent. of borax or boric acid as a bond. To reduce the danger of silicosis 1 per cent. of water is added to the batch. This does not destroy the insulation. The grading recommended is:

On 7 mesh ...	14 per cent.
7-25 mesh ...	38 per cent.
25-72 mesh ...	8 per cent.
72-150 mesh	18 per cent.
Through 150 mesh ...	22 per cent.

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For further details and references to original works the reader is recommended to study the following:

J. H. Chesters, *Steel Plant Refractories*, Sheffield, 1944. J. H. Chesters, L. Lee and J. Mackenzie, *Trans Brit. Cer. Soc.*, **48**, 263, 1948-9. *Manual of A.S.T.M. Standards on Refractory Materials*, p. 190 (Amer. Soc. Test Materials, Pa., 1952).

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THE BRITISH POTTERY MANAGERS' & OFFICIALS' ASSOCIATION

Industrial Instruments and the Pottery Industry

by P. R. PRIOR
(Honeywell-Brown)

IT is my belief that some of the developments that have taken place in industrial instrument design during and since the war represent great strides forward in this young, but rapidly growing industry. The ever-increasing demand for better instruments for the war effort, followed by the post-war requirements of the petroleum, chemical and metal industries, has meant that a great amount of research and design improvement has taken place. It is because I believe that instrument users within the pottery industry are just as interested in improving their products, modernising their plant and cutting their costs, as were the people in the industries I have just mentioned, that I wish to speak to you this evening. In telling you of some improvements that have been made within the last few years, I shall spend the bulk of the time available in connection with the measurement of temperature, as I feel that this one variable is possibly the most important to many of you, and it also represents a field in which much progress has been made.

Temperature Measuring: A Short History

The latest instrument used for the measurement, indicating and controlling of temperature is the electronic potentiometer. This instrument represents the most modern aspect of temperature measuring and was developed from the mechanical, or galvanometer-type potentiometer which it has almost made completely obsolete. The mechanical instrument was in turn developed from the millivoltmeter, and it is these three stages on which I wish to spend a little time.

The Millivoltmeter

During the late 1920's, the deflectional moving coil type of pyrometer was in general use, and it gained much popularity in industry generally. As you will know, this type of instrument consisted basically of a moving coil, and pointer assembly, either pivoted or suspended between the pole pieces of a permanent magnet, and used to indicate or record the E.M.F. developed by a thermocouple. The measuring element is normally connected in series with the moving coil, and a resistor, this latter being used to calibrate the instrument by means of its property of varying the current flowing in the coil by changing its value. When in use, the needle deflects, and reaches a balance point, where the electro-magnetic turning effect, caused by the steady current flowing in the coil, inside the magnetic field, is balanced by the restoring torque, applied by hair springs, mounted usually above and below the coil. The scale is normally graduated in terms of millivolts, or temperature, and is formed as a function of field distribution, and input characteristics. To provide recording, a chart driven by a hand-wound clock, or a synchronous A.C. motor, passes under the pointer, and a depressor bar is periodically caused to rise, and is then tripped, when it falls by gravity striking the pointer, which through a coloured ribbon produces a mark on the chart.

This type of instrument has definite

A talk given to the British Pottery Managers' and Officials' Association at the North Staffordshire Technical College, Stoke-on-Trent, on 29th November.

advantages, the most important being:

(a) Its extreme simplicity.
(b) Its relatively long life.
(c) Its low production cost, which in turn, means low initial cost to the user.

Unfortunately, the disadvantages of this design were found to cause it to be unsuitable for many industrial applications. The following being the more serious:

(a) Accuracy was rather poor being seldom better than ±1 per cent. of full-scale reading, and it depended on stable field distribution and strength.
(b) The accuracy was affected by external resistance of thermocouple, and compensating leads, which meant that very careful application was necessary.
(c) Suppressed ranges were difficult to arrange, due to the requirement of accurately cutting the hair springs.
(d) Automatic cold junction temperature compensation was a problem, but was usually overcome by anchoring one of the hair springs to one end of a bimetal spiral, which was itself anchored to the instrument frame, instead of attaching the hair spring itself direct to the frame.
(e) The instrument was comparatively delicate, due to the galvanometer movement and allowances for the effects of vibration, dust, etc., had to be made. In association with this, should be mentioned that regular maintenance service is usually necessary, to prevent dirt impeding the movement of the coil between the pole pieces, and to ensure that pivots, where used, do not become blunted, as this brings about stickiness of the movement, which is serious, particularly in the case of controlling instruments.
(f) The instrument is usually not stable, over long periods of time, due mainly to magnet strength falling off, and consequently frequent calibration checking is advisable.
(g) Due to lack of power usually available, narrow scales and charts are normally used.

The Mechanical Potentiometer

About 1930, several companies introduced a mechanical null-balance potentiometer to the market, as it was felt that this instrument would satisfactorily overcome the inherent shortcomings of the deflectional type, as it provided a more stable, more accurate, and more powerful and robust instrument. The potentiometer is basically an electrical device for measuring unknown voltages, usually small ones, and is in principle a calibrated slidewire, through which is passed a known current providing a calibrated voltage drop across the slidewire, the portion of which determined by the position of the slidewire contactor is opposed to the unknown E.M.F. Since the voltage drop along the slidewire is known to be linear, the position of the contactor can actually be measured with a ruler from some reference point, and thus the magnitude to the unknown voltage is determined.

When used for pyrometry, the unknown voltage is normally that supplied by a thermocouple, and the state of unbalance between the opposing voltages is usually detected by a galvanometer whose pointer position is periodically sensed by a continually cyclic mechanism. By means of a series of individual grabs or steps, each of which is proportional to the instantaneous unbalance, the slidewire contactor is moved to a balance point through a series of links or connections, until the unknown voltage is equalised, when the galvanometer returns to its central position, and no further movement takes place, unless the unknown E.M.F. changes.

This instrument overcame the more serious disadvantages of the millivoltmeter, as its operation was reasonably independent to external resistance, and the design of its measuring circuit allowed for ease in providing suppressed ranges, and automatic cold junction compensation. In addition, due to the principle of null-balance it provided good accuracy, of the order of ±¼ per cent., and good reproducibility. The inherent power available allowed wider scales and charts to be introduced, and all in all a more robust instrument resulted.

These advantages were quickly recognised by users, and this pattern of instrument rose to extreme popularity

about 1938. Its wide use in industry brought out, however, several obvious shortcomings, as did the use of the millivoltmeter instrument some ten years previously, and the advances in design of new plants and producing technique, called for even better instruments. By comparing the properties of the mechanical potentiometer with field requirements, the following disadvantages became apparent:

(a) Sensitivity or response was rather poor being a function not only of external resistance, but also of some step table or gripping mechanism which involved movement of mechanical parts, which naturally had some inertia.

(b) Due to the requirement of a large number of moving parts, maintenance seemed unnecessarily excessive, particularly on continuous processes, and where multi-record instruments were used.

(c) Due to its step motion towards balance, the instrument was unable to continuously follow temperature changes, which introduced not only an unncessary instrument lag, and also synthetic responses to input changes, causing non-linear corrective control action.

(d) The instrument was generally unsatisfactory when required to record rapidly-changing variables, or to provide continuous recording of a large number of points.

(e) Again, due to the presence of a moving coil detecting element, vibration and dirt effects, while not so serious as in the previous instrument, still effect the general operation. In addition, heavy shocks could not be tolerated otherwise galvanometer suspensions would be broken.

The Electronic Potentiometer

Bearing these points in mind, our own engineering department set about producing an instrument, which would satisfactorily overcome the shortcomings of the mechanical potentiometer, and the obvious answer was to introduce an electronic system for detecting balance of the potentiometer circuit. It should be pointed out that it was considered, at that time, unnecessary to basically change the measuring circuit of the instrument, as the one used up to that date was found to be entirely satisfactory from the standpoint of accuracy and simplicity, and all the efforts in improving the instrument were directed at handling the D.C. unbalance potential available.

The problem then resolved itself into finding a method of utilising our D.C. unbalance, in such a manner as to drive the slidewire contactor to point of balance in opposition to the unknown E.M.F. Initially, D.C. amplification was attempted, but at that time, 1937-38, techniques in this particular field were not as highly developed as they are now, and due largely to stability difficulties, this approach was abandoned. About this time, a patent taken out earlier for an electric control operation was discovered, and this provided the necessary freedom of development to drive a two-phase A.C. motor to a balance condition out of the power amplifier circuit. By means of using a mechanical vibrator to convert the unbalance D.C. potential to an A.C. of sufficient quality and stability to be amplified to drive that power amplifier circuit, the skeleton of the electronic instrument was formed.

Details of the Honeywell-Brown Instrument

At this point I propose to pass from the rather general aspect of this subject on to particular consideration of the instrument developed by my company. As mentioned before, the basic measuring circuit was unaltered.

The polarity of the D.C. unbalanced voltage will occur when the thermocouple potential is above that of the slidewire, and will be reversed, of course, should the slide-wire voltage exceed that of the thermocouple. In either case it is converted in the conversion stage by means of a vibrating reed type of converter, and then by means of an input transformer. The alternating voltage of mains frequency is produced at the secondary. The voltage amplifying section is then used to control the power amplifier, which in turn feeds one phase of a two-phase reversible balancing motor, the other phase being continuously connected to the supply voltage. The direction

of the motor is such as to drive the slidewire contactor to its balance point by means of a suitable mechanical linkage, and when this condition is attained the input naturally disappears, and balancing motor operation ceases. This general arrangement appeared to provide the answer to the shortcomings of the mechanical potentiometer in as much as:

(a) It provided an instrument, which, using an unbalance voltage to drive the slidewire contactor, gave continuous measurement, which operation gave the ability to arrange for linear corrective control action to input changes.
(b) It provided an instrument whose sensitivity was only limited by amplifier and slidewire design.
(c) By simply changing the motor speed, it provided the ability to follow rapidly-changing variables and by balanced printing, the ability to record large numbers of records with very small intervals between recording.
(d) The apparent maintenance requirements were very much reduced, due to the removal of galvanometer and cyclic balancing mechanisms. In actual fact the single-point type of instrument has no moving parts at all, unless actual temperature changes occur.
(e) Since all delicate parts had been eliminated, the instrument would be exceedingly robust, and its operation would be independent of attitude or movement.

Forms of the Instrument and Applications

The basic design that I have described to you is applied in many ways to your industry. The potentiometer as such, can be a circular scale indicator, a circular chart recorder or a strip chart recorder, each of these latter types having a scale for indicating purposes, length 28 in. in the former case and 11 in. in the latter. Five speeds of operation are used, varying from 30 sec. down to 1 sec. for full-scale deflection time, although probably only the 30-sec. and 15-sec. instruments would have ready application in the pottery industry. It is a sound principle that the speed of measurement and control must match that of the process and when the temperature of kilns is the variable under consideration, normal response-times are desirable since unnecessary high speeds serve only to increase initial costs and maintenance.

Multi-point recorders and indicators are readily available since the continuous balance operation of electronic potentiometers lends itself ideally to such arragements. Strip chart recorders with up to sixteen records are usual and indicators which can be either single or double range, are fitted with up to forty-eight push-button switches. This latter instrument has a very ready use on continuous tunnel ovens, particularly when one range is for base-metal thermocouples and one is for rare metal. The one instrument can therefore be used for measuring temperatures in both preheat and cooling zones and also in the firing zone.

Since the pen and pointer of the electronic potentiometer are motorised, it is a relatively easy matter to add control mechanisms to the various types of instrument. A range of controls including mercury-switch contacts, electric proportioning and two-term controls and also pneumatic controls are required by various applications and are therefore fitted as necessary. Recent developments in this field include the use of totally enclosed micro switches which have the following advantages:

(a) High current-carrying capacity 5A at 230V.
(b) Unaffected by vibration, dirt or position in space.
(c) Very narrow differentials available.

Two very recent developments in the electric proportioning control forms should interest users of electric kilns. These relays are used with any of the potentiometers previously described and provide modes of control known as "time-proportioning" and "position-proportioning."

Time-proportioning. This form of control has been introduced to meet the requirement of proportioning control on small electric kilns, usually of the batch type, and where control of input power cannot be made by variable transformer or by voltage regulation. The load contactor is operated such that it *makes* the circuit

at regular intervals, but *breaks* the supply after a period which is adjusted by the temperature controller. The power is, therefore, pulsing and the "time-on" determines the over-all power supplied. The relay recognises demand changes and compensates accordingly.

Position-proportioning is the term given to a similar two-term mode of control, but where the desired result is achieved by positioning some regulator rather than varying a "time-on" period. The relay usually operates in conjunction with an electric motor, and its application to motorised fuel valves will be obvious. An interesting application to larger electric kilns has recently been developed, where a motorised contact operates a variable tapped transformer. This system is more applicable to larger kilns than the pulsing type since the latter is limited by load contactor rating.

Owing to the easy use of increased speeds it is feasible to use multi-point controllers, whereas up to the present, the galvanometer instrument was too slow for this service since the "out-of-control" times were too long for good control. However, it is now feasible to have up to sixteen control circuits on one recorder which also provides recording and indicating of every temperature. Double index instruments can also be provided for two-position or proportioning control. These various specialised controllers are not necessarily suitable for all types of kiln, but they can often be applied carefully so as to effect considerable saving in initial cost and yet provide efficient operation.

Programme Control

The use of instruments in which it is possible to set a predetermined programme of temperature, is becoming increasingly popular. This method is one which can achieve considerable saving of labour and which ensures the correct processing of the ware. An instrument has now been designed which incorporates the best features of both conventional controllers and programme pattern transmitters. A cam is used to position the control index and the desired sequence is plotted on the cam blank which is then cut to shape. The instrument is then a conventional controller having two-position or proportioning modes and a record is provided on a circular chart. To achieve all of these functions in one item of equipment is an advance which, once again, reflects very well on the economics of these new instruments.

In some quarters there appears to be a tendency to install batches of intermittent kilns instead of continuous tunnel ovens. While not wishing to enter the lists on this controversial subject, I would say that the programme controller provides a ready means of subjecting the ware in an intermittent to the same temperature pattern as a tunnel oven.

Radiation Pyrometry

Up to this point I have made only passing reference to the actual temperature sensing element. The most widely used phenomenon is the thermo-electric effect produced when the junctions of two wires of dissimilar metals are at different temperatures. Since most temperatures that are measured in kilns and furnaces are relatively high, the thermocouple is in widespread use. It has the following advantages:

(a) Low initial cost.
(b) Simple to manufacture.
(c) Easily replaced.
(d) Generally robust and easily handled by the unskilled.

However, there are many applications to which a thermocouple cannot be put satisfactorily, and the total radiation pyrometer can be used to advantage in these cases.

Its points of advantage are:

(a) Is stable over long periods of time and due to its not being actually in the furnace atmosphere, is unaffected by injurious gases.
(b) High E.M.F. output now available means that narrower spans can be used.
(c) Actual work temperature can be measured under suitable conditions.
(d) A wide range of temperatures can now be measured covering 125-7,000° F. if necessary.

Early radiation pyrometers comprised a fine thermocouple with a reflecting mirror behind, and received energy was focused by a lens on to

the thermocouple via the mirror. This type had the disadvantage that it was rather delicate, and the E.M.F. output was low owing to the fact that the actual temperature reached by the thermocouple was not high. In addition, the mirror surface deteriorated, causing changes in calibration.

A radiation head has been developed which employs ten thermocouples in series, or "thermopile," and these are rigidly held in ring form such that all the hot junctions are at the centre of the circle. The received energy is focused directly on to this point, thereby obviating the use of the mirror. A high E.M.F. is therefore available and reproducible calibration can be effected under black-body conditions, and Temperature/E.M.F. tables can be published. A very robust unit, complete with built-in calibration adjustment is therefore produced. The lens material is selected to suit the wavelengths of the energy within the range for which the instrument is to be used.

Many applications of this instrument could be described if time permitted, but two are of particular interest and I will cover these briefly.

Several companies within the United Kingdom, and also others in the United States of America, are concerned with developments of refractories to withstand extremely high temperatures. For such development work it is obviously necessary to have available a small heated space which can be raised in temperature beyond that normally expected and there are in fact regenerative furnaces designed which will reach 2,300-2,400° C. The problem of temperature measuring and even of controlling these furnaces is fairly complex, but a particular model of the radiation pyrometer has been developed which can be used at these elevated temperatures and which needs a very small target size. It is of utmost importance to maintain any sighting hole at a minimum, since heat losses through such apertures can be very considerable above 2,000° C. A target diameter of $\frac{1}{4}$ in. at 12 in. or $\frac{1}{2}$ in. at 24 in. is therefore used and it is usual to air-cool and water-cool the measuring head.

The second interesting use of such instruments also concerns the small target type of radiation detector, as it has previously been impossible to use radiation pyrometers with multi-passage kilns where it is necessary for good control to obtain a temperature inside the element tubes. These tubes which carry the electric elements usually run perpendicularly to the passages, and when thermocouples are inserted trouble is often experienced with electric leakage from the element itself due to the poor insulating properties of refractories at high temperatures. Once again, the feasibility of having an externally located radiation detector sighting inside these tubes is now feasible since their internal diameter is usually of the order $\frac{1}{2}$-$\frac{3}{4}$ in. which is suitable for the small target requirements.

Economics

And now, gentlemen, there is possibly one question which has occurred to some of you, and that is "what is the relative cost of these improved instruments?"

It is, of course, very difficult to draw comparisons, particularly when the types of equipment concerned differ basically. However, some useful relative evaluations can be made, and some guidance can be given to prospective users.

The cost of instrumentation must always be contemplated in the light of the following:

(a) The improved yield of saleable ware that will result.

(b) The labour costs that will be saved due to release of operators for other work.

(c) Possible saving in initial kiln costs.

(d) The cost of maintaining the instruments once installed.

(e) The reliability of the instruments.

Comparisons against headings (a) and (c) would probably show little difference when considering mechanical versus electronic potentiometers.

However, the choice of improved controllers can influence the cost of labour for kiln operation to quite a high degree. The use of programme or multi-point controllers now made feasible by the increased speeds of response of electronic potentiometers, often means that fewer operators are required to process a given quantity

of ware in a given time, and such savings can amount to a considerable sum over, say, five years, with the present high wage levels.

Under heading (e), regarding the reliability of the equipment, surely it will be agreed that the most reliable equipment is preferred by the average manager. A direct comparison of initial costs of electronic and galvanometer instruments will often show a price advantage in favour of the older design. This is to be expected, since the production of high-quality precision equipment must reflect in initial price

Nevertheless, the elimination of delicate moving components in favour of robust static parts, does increase over-all reliability and advances in design of present-day electronic equipment fully justify their use in industry. Peace of mind regarding the operation of a plant when you are not there is very valuable!

Possibly one of the greatest savings that can be achieved by the use of the newer equipment is in routine maintenance. Careful figures have been kept in some plants, and accurate comparisons between the conventional galvanometer instrument and the continuous balance type have shown maintenance costs over three or four years to be as little as one-tenth in favour of the latter type. Service costs are often hidden and it is not until a check is taken that the high figures for galvanometer instruments are obvious. It should be fairly clear from the foregoing, however, that continuously-moving parts will need more attention than the static equivalent. It is a mistake, I feel, to relate the initial cost of instruments to the initial cost of the kiln, as in some instances these may appear out of balance should such comparison be made. Rather that the instrument costs be considered in the light of the above suggestions.

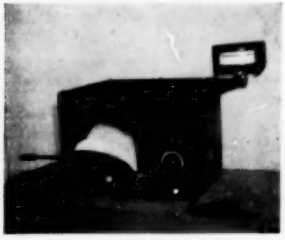
Conclusion

If my statements on the development of this instrument are remembered, it may occur to query whether we have now produced the perfect instrument, or are we actually in a position to start all over again.

I personally think that this general basic type of instrument will stay in pretty much the same form for some time yet. Increased speeds of operation will undoubtedly be made available for certain specific applications such as spectrometry, etc., but for the general run of the mill applications the variety of speeds now available seems to suffice.

I do think a lot of development work will be done to better the reproducibility of such instruments by an attempt to produce constant voltage sources, elimination of strays, errors in cold conjunction compensation, etc.

However, I think the point has now been reached where the tail is more or less wagging the dog, and the greatest development work must be put into providing more accurate, more reproducible, and much speedier primary measuring units, i.e., thermocouples, resistance bulbs, etc.



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Recruitment, Training and Education in the Heavy Clay Industry

by

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THE question of education in the ceramic industries has recently become a matter of some interest and discussion among the various sections of the ceramic industry, and in particular to that section dealing with heavy clay wares. I need only remind you of the apprenticeship scheme recently adopted by the brick and allied trades in which education is an integral part. After a good build-up in the technical press this scheme now seems to be languishing. Since this audience is mainly concerned with brickmaking I propose to devote my remarks tonight to that industry, though as you know I am equally concerned with all the other sections of the ceramic industries some of which appear to have progressed further in their training schemes.

Conditions of Work

In considering schemes of education for employees in the brick-making and allied industries one finds it impossible to divorce the issue from the conditions of work in the industry, and their effect on the recruiting of new entrants, since the quality of the latter and their previous education have a profound bearing on the type of instruction that can be given.

I think we should agree that as a result of training schemes we aim to improve the type of entrant and the status of the industry generally, working on the principle that an intelligent workman is probably a better one.

Frequently one hears it said that lads are not attracted to the clay industries, and the ones that are are not worth training, or that they evince no desire to take advantage of facilities for further education. This is undoubtedly true in some cases as things are at present, and one suspects is often made the excuse for a policy of inaction.

What we have to examine is why the type of entrant to the industry is so poor in some cases, and to discover whether this is due to our own shortcomings.

At the present time officials of the Ministry of Labour are often called upon to supply information to parents on the prospects in various industries, since school-leavers often have no particular preference for one job over another.

Again, there are career masters at schools whose job it is to point out to school-leavers the various types of opening available. Do they recommend the clay industries as potential sources of livelihood, and if not what are the reasons?

It seems to me that in the past there were several reasons why work on a brickyard was apparently unattractive, and in many cases these reasons are still valid.

1. Clay working is a dirty occupation.
2. These appear to be dead-end jobs

* *A talk given to the North Staffs Branch of the Institute of Clay Technology on 8th November*, 1954.

with few prospects of advancement.

3. Wages and salaries are often comparatively low.
4. Other industries have offered better facilities for study and advancement. These include time off from work, grants towards fees and travelling expenses, and prizes for the best students. In some cases education and welfare officers have been appointed to look after student trainees.

We hope that the new apprenticeship scheme will be a step forward in removing some of these drawbacks since the employer agrees with the parents or guardian that a new entrant shall be taught progressively all the various phases of brick-making and not just kept driving a dumper or taking bricks off a press. The practical training a lad receives will depend a lot on the type of foremen and managers.

Education and training schemes will eventually improve the quality of these, provided that a salary comparable with that paid to works managers with similar responsibilities in other industries is being paid as an inducement to recruiting the best men. A cheap man is often expensive when bills for plant maintenance are considered. At present the heavy clay industry still cannot offer the inducements to youngsters that, for example, the engineering trade does, and as long as that persists the number of entrants will be low and their standard will be similar, and we shall continue to operate in a vicious circle.

Another point which merits consideration is that of publicity in bringing careers in the clay industries to the notice of young people. I know that there are good opportunities today in the industry for men of the right education and training, particularly with firms that have put their houses in order, but I am convinced that in many quarters this is not appreciated. I feel the industry could do a good job by taking steps to bring brick-making as a career to the notice of schools and colleges for jobs at both the artisan and managing levels. At the same time Junior Employment Officers should be made aware of the same facts.

Type of Instruction

Before educational facilities can be offered we must first agree as to the type of instruction that is to be offered and undoubtedly the co-operation of the Ministry of Education and local education authorities will have to be sought in setting up classes at strategic points.

In some cases managements will have to face up to providing transport for this. I may add that I have pottery students who are sent a distance of about 50 miles one or two days a week to attend classes in Stoke.

As regards the type of instruction to be given we must I think differentiate between various levels. This fact was agreed in a meeting convened in Birmingham by the Institute of Clay Technology in February, 1951, and which was attended by representatives of that body together with others from the British Ceramic Society, the Ministry of Education, the Northampton Polytechnic, and the North Staffs. Technical College. The findings were subsequently reported to the National Federation of Clay Industries and were also embodied in a paper read to the Clay Convention by Mr. A. J. C. Watts. These were that steps should be taken to set up courses which could be attended one or two half-days a week for men who wished to qualify as under-managers. The course should be of three years' duration and instruction should be given in science, engineering and clay technology. Finally, provision should be made for selected students from these courses to attend the full-time courses for managers at the North Staffordshire Technical College. In so far as it makes no provision for training the artisan type this document is only a stop-gap to fill a pressing shortage of trained under-managers and higher grades. It is the prospect of training and educational facilities for all new entrants that is likely to make recruiting of new entrants simpler. While all trainees cannot attain to the top jobs the competition is likely to improve the quality of those who get there.

Training of Artisans

I submit, therefore, that we need three types of training. The first as a craft type of training such as is envisaged in the apprenticeship scheme

when properly carried out. This will ensure that the new entrant is taught all the various jobs on the brickyard by actually doing them so that his peculiar aptitudes may be discovered. He should at the same time improve his general education since he may eventually be the type that could receive further education and training as a foreman, under-manager or manager. He should, therefore, be provided with facilities for improving his general education at the nearest junior technical school with instruction in mathematics, science and elementary engineering with some simple instruction in the properties of clays with particular reference to brick-making until these courses are set up, or if the numbers of trainees in a particular area do not permit such a course being started then I suggest the scheme adopted recently by a firm near Sheffield be used, namely, that the lads are sent to the nearest technical college to study mathematics, science and English. (Incidentally, the best lads from this course subsequently attend the three-year full-time course at Stoke, the firm paying the expenses.) This particular firm has to send these lads about 12 miles each way to the nearest college. The industry will also probably be called upon to assist in finding instruction for the clay technology classes.

I should point out at this stage that my experience shows that it is useless to make attendance at these classes voluntary. There are all too many, including the lad's workmates, who will try to dissuade him from attending. At such an age the trainee is in no condition to judge what is best for himself. Consequently, attendance must be compulsory, as is the practice in other industries, and absences must be accounted for and, if necessary, the pay stopped for unsatisfactory attendance.

Further Education

A student who has benefited by the education and training outlined above has got the necessary background to proceed to one of the more advanced courses should he be considered to have the qualities necessary for a foreman, under-manager, or manager. Obviously the number of these to be trained each year will be much less than the artisan group. It seems inevitable, therefore that courses for them will have to be concentrated in a few centres either on a part-time or full-time basis.

At present we are operating a stop-gap scheme at Stoke for foremen, and on account of the distances involved this is a concentrated course for six months on a full-time basis. To date two courses have been run and until the next one, commencing January, 1955, the trainees have all been sent from the National Coal Board, who as you probably know operate some fifty-odd brick and similar works. It is a matter of some concern that of all the firms making bricks and refractory materials in this country only six students have been forthcoming each year despite very thorough advertising in the technical press.

For this course the subjects taught are clay technology, science and foremanship, and the lectures are followed up by comprehensive practical work, in which the students are encouraged to work on their own raw materials and to compare the results with those from other areas. Weekly works visits are also a notable feature of the course. Despite the fact that the men trained under this scheme had in many cases not had a secondary education, the results achieved have been surprising, and illustrate how enthusiasm can often triumph over difficulties.

Training of Managers

The training of the top-grade men such as managers and under-managers calls for a blend of theoretical training and practical experience, and the most satisfactory way of combining this is in the sandwich scheme as operated for the Managers and Under-managers Certificates of the North Staffordshire Technical College. Under this scheme selected students with suitable educational background are sent to the College for six months' full-time study in each year for three years, the rest of the time being spent on a brickyard or a tile or pipe works. The theoretical studies including engineering, with particular reference to the utilisation of steam and electric power on a works, workshop practice, and machine drawing. Chemistry and physics are taught as far as are necessary for the

lectures in ceramic technology, and in addition lectures are attended in such subjects as time study, works accounting and costing, sales organisation, commercial law, etc. This course is attracting more men each year from the heavy clay industry, and its success can be judged by the fact we regularly have a greater demand for qualified students than can be satisfied, and our old students are located all over the world as the Managers Certificate is universally recognised.

We regard the emphasis on practical training as contributing in no small measure to the success of this scheme. It should be emphasised that the student does not get a Managers Certificate on examination results only. In addition he must satisfy a Board of Examiners drawn from industry that he is a competent man by an oral examination. If he fails this, even though he has passed the theoretical examination, he must re-present himself for the oral in twelve months' time or at a later date. Having passed the oral and theoretical tests he must also satisfy the examiners that he has had six years' experience in the industry and that for two of these he has been employed in some responsible capacity.

Needless to say such training is expensive to provide and there are good grounds for stating that such facilities will not be provided outside Stoke, at any rate until there is a substantial demand from industry to justify it. Our new department which is in course of erection will cost £200,000 for the building alone.

Can the Industry Afford It?

Some may query whether they can afford to send men to Stoke for six months in each year for three years. In this connection I would reply that if the status of brick-making and the allied industries is to improve, the industry dare not do otherwise, since other branches of the ceramic industry are doing this already, and in consequence will attract the best men, possibly away from brick-making. In this connection I may mention that one firm in the heavy clay trade has entered three student trainees for the managers course this year, and hopes to send others in later years. Again a large group in the pottery industry has entered four trainees this year, and hopes to take in four trainees each year. Incidentally, the wages paid to these trainees would give some brick-makers a good deal of food for thought.

Again, may I draw your attention to a national scheme for student apprenticeships operated by the British Clock and Watch Manufacturers' Association Ltd. Among other provisions the Association agrees to pay the wages of students on an agreed scale for the three years' full-time study and then to take the trainee on to a works for a further period of two years on a higher wage scale.

You will see, therefore, that the heavy clay industry, in particular the brick section, is up against very stiff competition in the market for labour. At present, with a few exceptions, there are no facilities available for further education and training on a scale comparable with that operated by other industries. The facts were well ventilated in 1951, and an apprenticeship scheme is now in being. A real attempt should now be made at national level to break the vicious circle of poor conditions attracting poor-quality labour, and thereby to improve the status of the industry.

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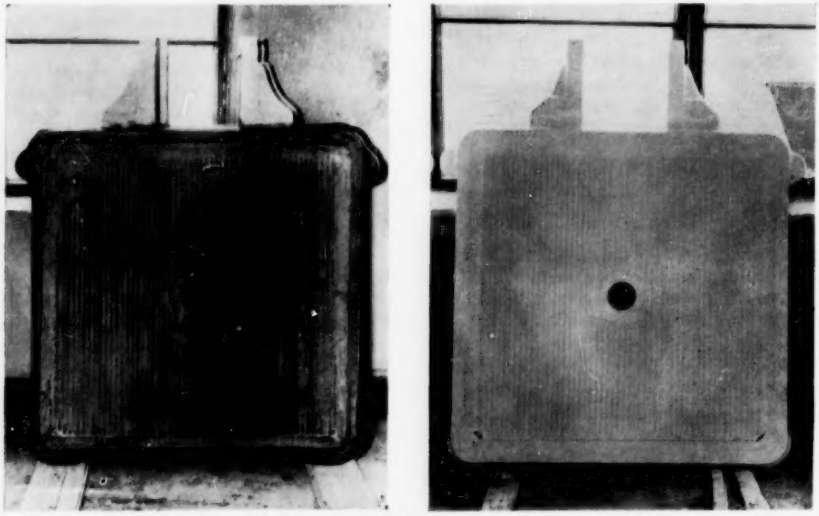
Combating Corrosion in the Potteries

A FIRM well known for the manufacture of decorative tiles has recently adopted a process known as chemical pretreatment for combating corrosion on considerable quantities of their equipment and structural steelwork. The problem is a serious one. Stoke-on-Trent, where the firm has its factory, suffers, with most of the other Potteries' towns, from severe industrial pollution of the atmosphere. This is, in fact, one of the most important causes of the corrosion, and contributes in a large measure towards the loss of steelwork through rust in many of our larger cities.

There are, in addition, a number of factors common to most works of this kind which encourage the development of corrosion. Some of the metal surfaces are subject to constant condensation, others to extremes of temperature and are hosed down with cold water after use.

The threat of corrosion is such that the painting contractors to the firm have established a system of regular inspection covering almost every item of metalwork within the factory. The importance of their task may be seen in the fact that they have found that on some of the equipment corrosion can seriously jeopardise the tile quality and output. In pipes, for instance, a mere pin-head of rust introduced into the clay mixture will cause the rejection of pounds worth of tiles. Similarly, a flake of rust falling from a girder can render useless many square yards of tiles by causing serious discoloration and staining. All these problems have substantially been solved since the adoption of chemical pretreatment.

Equipment to be treated at these works includes tile cages (used for stacking), the outsides of cylinders for mixing glazes, the filter presses and their seventy filter trays, the doors of the biscuit kilns, girders and other



Before and after: Filter plates are essential components of the filter presses. Each press contains seventy such plates. The left-hand picture shows a plate in typical condition, before treatment; that on the right shows the plate after treatment and prior to painting

Before and after: (Left) A tunnel kiln, the doors of which have not been treated. (Right) Another tunnel kiln. In this case the doors were treated two years before the photograph was taken but had remained in good condition despite continuous use

items of structural steelwork, and several trolleys used for transporting tiles within the factory.

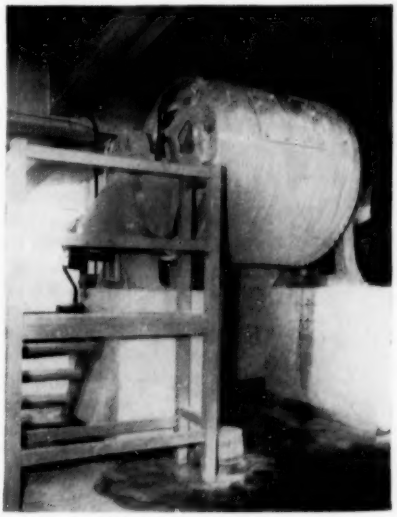
It is vital, of course, that the filter trays be kept free of rust and their painting systems be maintained in exceptionally sound condition. The pressing takes between 1½ and 2 hours at a pressure of approximately 95 lb. to the square inch. Paint flakes, the result of failure over a rusted metal surface, could become mixed in with the clay, resulting not only in long delays for renovation work but also in the wholesale rejection of considerable quantities of the material. Moreover, the actual pressing machines cost about £2,000 apiece and are too valuable to permit any deterioration through corrosion.

A somewhat different problem concerns the doors of the biscuit kilns, where the tiles are fired at 1,100° C. for more than four days. Here the presence of steam and sulphurous gases complicates the already serious problem of temperature extremes, and in the past these doors have rusted severely. Again chemical pretreatment has put an end to the trouble.

The anti-corrosion method used at these works is known as the jenolizing process. It entails the simultaneous removal of rust and the deposition on the metallic surface of a phosphate coating which inhibits future corrosion and keys the surface for paint adhesion. Application may be made by tank immersion, spray equipment or brushing. In this instance, the solution is applied by the last method, with intermittent wire-brushing of the surfaces. Paint coatings are applied immediately the treated areas have dried.

In order to reduce production delays to the minimum, the renovation has been applied to each item of equipment only as and when it became necessary. It seems clear that the chemical process has considerably improved the finish on the large quantity of steelwork already treated, and will reflect a substantial reduction in maintenance and renovation costs over a period of time.

For further information regarding this process, application should be made to Jenolite Ltd., 13-15 Rathbone Street, London, W.1.



A glaze grinding cylinder for grinding basic glaze frits with water to obtain fine water suspension. It has been treated

Hungarian Pottery in Paris

by

a Ceramics Correspondent

FROM behind the Iron Curtain has come an extremely interesting exhibition of Hungarian Folk Art, arranged at the Galerie Bernheim Jeune in Paris by the Parisian Literary and Artistic Agency and the Hungarian Institute of Paris.

The colourful exhibits include traditional costumes, hand-woven fabrics, wood sculptures, furniture and embroideries, but nearly half of the show is given over to pottery, of which 226 pieces are presented.

While the potter's art in Hungary goes back many centuries, the pieces shown here are all of nineteenth- and twentieth-century manufacture since the potteries of the Middle Ages in Hungary were confined almost entirely to table ware and other objects of utilitarian value, enamelled on the inside only and without any decoration. In the seventeenth century, however, decoration was introduced by an Anabaptist sect which had fled from the southern Tyrol and which had a much more developed pottery art. At approximately the same period another influence was felt, due to the Turkish domination, and Asia Minor influences are still very obvious.

This influence is particularly apparent in the floral motifs used throughout the various regions of modern Hungary, for we find constantly repeated on the potteries shown the rose, carnation, tulip, etc., which are basic motifs in Turkish carpets, tiles and ceramic ware.

In choosing the nineteenth and twentieth centuries, the exhibition starts from the period in which decorated potteries were first found in peasant homes. Enamelled pottery appeared in the nineteenth century.

A tall, slim vase typical of the ware made by the "New Town" quarter of the pottery town of Hódmezövásárhely

Peasant women are pictured here decorating the ware in two different ways. On the left, the decoration is applied by brush. On the right, the cornet is being used. This instrument is generally employed by women

with the decoration done either by brush or by cornet for both the floral and the line designs. No evidence of women potters is found, all forms being modelled by men, the decoration being applied by the women.

The Great Plain of Hungary was the most active centre of the pottery making, especially of the non-enamelled pottery, polished by pebbles and blacked with soot. Toward the end of the nineteenth century, however, the art declined, though a renaissance is taking place, due in large part to a government interest in the renovation of the artisan crafts.

The objects in the present exhibition are accompanied by explanations of the various types of work and their origins. Thus we learn that in former days the master potters of Pászto in upper Hungary, worked especially with the brush. The development of the Sarospatak ceramics from the end of the eighteenth century to our own day can be traced easily. The vessels decorated with big flowers were famous throughout the region; the modern ones come from the workshop of Mme. Bertalan Szkirczak, who works entirely with the brush.

The master potters of Tiszafured mainly catered for the inhabitants of Mezöhövesd who liked very bright colours. One of the most traditional forms comes from this region—the pitchers called "Miska," representing jolly men. These were designed to hold wine as were the gourds and flasks for eau-de-vie, and were made only to order. This art which flourished in the nineteenth century almost died out, and its revival is due to a Karcag artisan, Sandor Kàntor. Strong yellows and ochres, greens or dark browns, as well as whites are used, in all floral and stylised brush designs.

The potters of Mezötúr were famous for their pitchers, and about forty artisans still work there, forming one of the most important pottery co-operatives of Hungary. Here the Badar family and Jànos K. Sébestyàn have begun to use the old ornamentation called "graffite," either stoneware effects with striped line decoration or glazed with flowers. The charming gourds stand on little feet and have stoppers and handles. The pitchers vary in sizes and forms. From here, too, come huge basins of glazed pottery, all hand-decorated.

One of the most distinctive forms of Hungarian pottery is the black pottery which was formerly made throughout the Great Plain. The vase, before

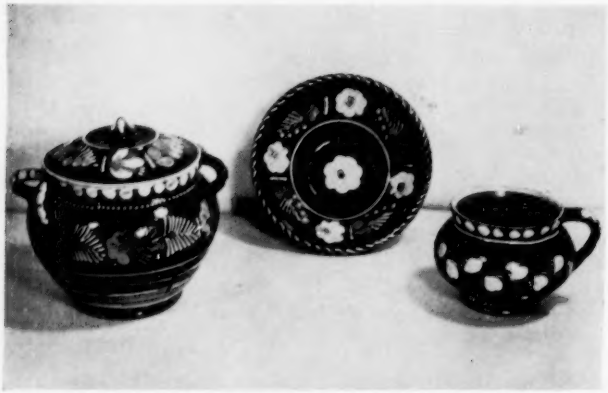


Table ware shown here is in ochre enamel with flower decoration which has been applied by cornet

being completely baked, was blackened by smoke. This ancient process was used by the family of the potter Istvàn Fazekas for many generations. The huge pieces are most handsome, with engraved designs, antique in effect, and were for water, oil, etc. The big water jars were carried into the fields and thrust well down into the earth to keep the water cool. Some of the modern black jars are lined in ochre; some have bronzed tints.

Hódmezövásárhely was *the* town of the potters in the last century. In 1860 there were as many as 450 master potters here, grouped in three sections of the city and each with its own special type, making pottery of different forms and colours. The Taban section made coloured eating bowls. Those of the "New Town" made slim tall vases, while those of the "Upper Town" made white containers. These old methods are used today by the master potter Sandos Vékony.

Once upon a time the potters of Tata made pottery for the whole Transdanubia in a style founded in 1758 by A. Csakvàr: pitchers with openwork necks, flat-sided eau-de-vie flasks with baked-in inscriptions, and "deceiver pitchers" whose secret one had to discover in order to be able to drink.

Among the objects from Szekszárd and Morád is a doughnut-shaped flask These potters work for the villages in the region of Sàrköz which is celebrated for its popular art traditions.

Left: Mezötúr type gourd; the floral pattern shows the strong Turkish influence. Centre: A water or wine pitcher of traditional colour and design. Right: This "Miska" pitcher, representing the Hungarian equivalent of Robin Goodfellow, comes from the Tiszafured region where bright colours are used

Quantities of black pottery come from here, either trimmed with bright colours, or all black; much ochre is also made. Many of the objects include in the decoration the Picasso "Dove of Peace."

Among the amusing and original items shown in the exhibition are a number of miniature jars and pitchers meant as children's toys; a two-part tobacco jar in the shape of a bear; a bottle in the shape of a book; a pretzel-shaped gourd. All sections of the country make the huge pottery jars with covers for storing grease.

Pulverised Fuel Ash Into Bricks

THE rapid growth in the burning of pulverised coal in power stations is making available large quantities of a new material which should be able to contribute to economy—and even to higher quality—in building and civil engineering work.

This new material is pulverised fuel ash the output of which has risen from about 750,000 tons in 1947 to cover 2,000,000 tons a year today and is expected to be some 4,000,000 tons by 1960.

As the pulverised coal, suspended in air, is burned in the combustion chamber, the ash is fused into small separate spheres, a few of which are hollow. As it emerges it is collected by electrostatic precipitators.

This p.f. ash is very similar to the volcanic ashes, or pozzolanas, used by the Romans in combination with calcined limestone as a cementing material when they built such enduring monuments as the Colosseum and the Pantheon. This combination continued to be widely used until the discovery of Portland cement less than 150 years ago. But unlike pozzolanas found in the earth's crust, p.f ash is already finely divided and needs no crushing or pretreatment.

Only in recent years have the possibilities of utilising this potentially valuable raw material begun to be systematically investigated in this country, although there has been some commercial use, for example, in the U.S. Now, however, research has yielded enough data on which extensive commercial development might be based.

The most promising avenues for the economic utilisation of p.f. ash in quantity appear to be:

1. Mixed with clay to produce bricks;
2. To replace part of the cement, or sand, in concrete;
3. To make concrete-type building blocks;
4. To form a lightweight aggregate, by sintering.

Bricks

Experimental work by the Building Research Station and several firms has demonstrated that it is possible to make good bricks from p.f. ash and clay in the proportions 80-90 per cent.: 10-20 per cent., provided the clay is of the plastic kind.

On a laboratory or pilot scale, bricks of good average quality have been made from 85 per cent. Hams Hall (Birmingham) p.f. ash and 15 per cent. Wilnecote clay, both slurry mixed and dry mixed and fired at temperatures ranging from 900-1,090° C.

Rye House (Hoddesdon) p.f. ash and London clay from Nazeing in the same proportions have also been made successfully into bricks. Trials with Hams Hall ash mixed with clays from the coal measures in the proportion 60:40 have been carried out at two of the National Coal Board's brickworks in the Midlands Division. When submitted to the usual tests the bricks containing the p.f. ash from one works did not differ significantly from those made entirely from clay. At the other works those containing the ash were slightly more porous and slightly lower in strength; but both sets of bricks containing ash were of excellent quality.

On the North-East Coast and in the Edinburgh district, the N.C.B. is taking samples of p.f. ash for experimental brick-making.

In Surrey and Sussex several brickworks are successfully using p.f. ash in varying proportions.

Since it is unusual to find an existing brickworks near enough to a power station to dispense with the need to transport the ash on wheels, one problem is the means and cost of such transport. The ideal vehicle for the purpose would probably be on the lines of the spherical containers devised for the pneumatic delivery of cement in bulk. But this problem need not present insuperable

difficulties once there is a firm long-term order for p.f. ash in quantity.

Another way round the transport problem is the erection of a new brickworks adjacent to a power station preferably located near a big market for bricks. Rye House, Hoddesdon is near the new towns of Stevenage and Harlow, not far from Welwyn, Luton and Bedford and on the very edge of the Metropolis. A site is available and all the necessary plans for the development of a brickworks on this site are in the course of preparation. Rye House turns out enough p.f. ash to make about 10,000,000 bricks a year. (The national output of bricks is of the order of 7,000 million —or 20,000,000 tons—per annum). The Authority is very willing to consider offers by brick-makers to use this site and the development plans.

Plans for similar developments are being investigated elsewhere by brick firms.

Concrete

In the United States and Canada p.f. ash is now widely used in mass concrete work to replace 20 per cent. of the cement used in ordinary concrete.

Experiments at the British Electricity Research Laboratories at Leatherhead have confirmed American (and Russian and German) experience that concretes in which up to 20 per cent. of the cement has been replaced by p.f. ash have a rather lower initial strength than ordinary concretes. But, with the lapse of time, the strength approaches that of ordinary concrete and at three months the two are equal. This is to be expected since the pozzolanic action of the fly-ash depends on the lime set free by the hydration of the cement, which increases with time.

For mass work where there is no early load to bear, this slower strengthening has advantages. Compared with straight Portland cement concrete, that containing p.f. ash gives off less heat so that temperature gradients across large masses of concrete are smaller and the danger of surface cracking is thereby reduced. Users say there is less segregation of aggregate and less "bleeding" with fly-ash concrete and that it is more resistant to attack by sulphates and the action of sea water. It is also claimed that fly-ash concrete is rather more workable.

In this country fly-ash concrete is already being used by the North of Scotland Hydro-Electric Board for dams and other civil engineering work. B.E.A. is using it for roads. In any large national road building programme the use of p.f. ash could save cement and money.

Building Blocks

Methods have been perfected of manufacturing from p.f. ash building blocks designed to replace bricks, concrete and masonry in all forms of walling, load-bearing and otherwise. Names known to the industry include "Melcrete," "Thermalite," "Licon."

The aim is to secure speedier, cheaper and perhaps better building; higher thermal insulation; lower loads to transport and easier and better finishing or facing. Such blocks use a very high proportion of fly-ash and will probably in time absorb a high proportion of the output of some power stations.

Aggregate

By the sintering process p.f. ash can be made into a lightweight aggregate approximately half the weight of gravel. The concrete made with such aggregate has not the full load-bearing qualities of that made with the usual aggregates, but a very large proportion of concrete work is not required to bear heavy loads; it is used to cover, clad and fill in steelwork. In such applications the reduction in weight for a given volume has important advantages. A lighter concrete cladding means a lighter steel structure and a saving of metal. At works, the cost of p.f. ash aggregate per ton will probably be rather higher than the cost of gravel. But as less weight will be required for a given volume of concrete, the higher cost per ton at works should normally be offset by savings on transport and in the weight of aggregate required.

Indeed, since the p.f. ash aggregate can frequently be made very near the building site (at power stations in cities, towns and populous areas) while gravel pits are often remote, it may well prove, ton for ton, no more expensive than gravel delivered to the site where it is required—and a ton of p.f. ash aggregate will go nearly twice as far.

Several firms of building contractors of national repute are actively considering plans to manufacture the aggregate by various different processes on power station sites. Some are well ahead with experiments and the Authority is offering every facility.

Since the national output of aggregate approaches 40,000,000 tons a year, this outlet for p.f. ash holds out considerable promise.

While the main use for p.f. ash aggregate would undoubtedly be for lightweight concrete it could also be used to make building blocks in substitution for the well-known clinker block made from power station clinker. Possibly bound with p.f. ash cement, these aggregate blocks would be roughly of the same

weight as clinker blocks but considerably stronger and generally better products. Successful experiments in making them have been carried out.

Apart from a few proprietary building blocks, none of the known methods of utilising p.f. ash has yet been commercially exploited on any scale in this country. Yet in several of the applications outlined above, the material promises to be of considerable value to the building and civil engineering industries, while the quantity available is constantly growing.

Now that basic research work—and experience in other countries—has demonstrated the possibilities, there is a need in this country for much more practical experiment, more extensive trials on an industrial scale and commercial development.

By no means all the possibilities have yet been explored. There is obviously scope for the development of new techniques which might prove very profitable to the building and building materials industries.

Pre-cooling Concrete Reduces Stresses

AN original method of cooling concrete for a massive structure that may prove of use in the construction of harbour works and fortifications as well as dams is being used in the construction of the Vaitarna Dam, Bombay Province. Part of a scheme for almost doubling Bombay's water supply, the dam impounds the flow of the Vaitarna river 75 miles from the city. It is solid gravity concrete, 1,820 ft. long at the top and 269 ft. high.

In a structure of this kind it is essential to control the temperature rise due to the hydration of cement. The generation of heat continues for some time after pouring, and unless cooling is employed the temperature inside the mass will be considerably higher than that of the exposed surfaces. Shrinkage will occur as the mass cools, causing stresses, and if the change from the peak to the final stable temperature is excessive the stresses will cause cracks which will weaken the structure.

Experience elsewhere in similar projects has shown that the tensile stresses are kept within safe limits when the difference between the maximum and stable temperature is no more than plus or minus 20° or 25°. At the Vaitarna Dam the air temperature varies from 114-52° F. and the water temperature is 85° F. The final stable temperature of the dam is estimated at 85-90° F. The temperature rise due to the hydration of cement has been calculated as being about 50° F. above the pouring temperature after about 52 hours of placement.

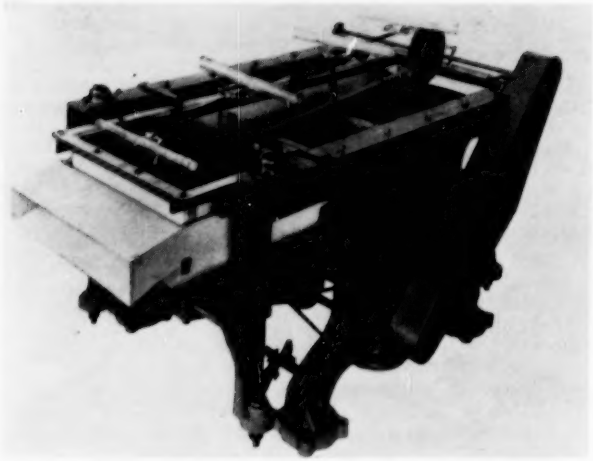
The normal temperatures of the components of the mix are about 100° F. With no cooling the interior heat of the concrete would go up to about 150° F. Therefore to keep the maximum heat to within 25° F. of the ultimate stable temperature the concrete is cooled to 60° F. when poured.

One method of cooling concrete is to build within the structure an elaborate pipe system through which refrigerated brine is circulated during placement followed by water to remove heat while the concrete is setting.

A simpler method is used at Vaitarna. After crushing and screening the aggregates are conveyed on six slow moving belt conveyors through a cooling tunnel, which is 330 ft. long and cork-insulated. In conjunction with this there is a Freon cooling plant having a refrigeration capacity of 650 tons. During transit through the tunnel the coarse aggregates are cooled to about 40° F. by chilled water sprays and inundation, and afterwards passing through a high velocity blast of moisture-free air chilled to between 40° and 42° F. The fine grades are cooled by the chilled air only, the temperature being reduced to 72° F. The mixing water is chilled to 36° F. by the same cooling plant. The cement is not cooled before mixing.

The chilled air is circulated by eight Aerofoil fans manufactured by Woods of Colchester Ltd., each delivering 27,500 c.f.m. With this cooling system the temperature of concrete at mixing is 57° F. The pouring temperature is 60° F. and has been as low as 58° F.

Since the commencement of the project in May 1952 over 20 million cu. ft. of concrete have been poured and the required placement temperature has been constantly maintaind. The cooling system has operated continuously without hitch or failure.



The new Russell Separator

A NEW SEPARATOR

AT the recent Packaging Exhibition in London, which closed on 28th January, one of the most interesting pieces of equipment was the Russell Separator with submerged mesh. In this machine the straining operation takes place through a screen submerged in the liquid and one of its most effective applications is for straining out sand and bag fluff from sugar water. The static underpan is constructed to maintain a predetermined level of liquid before this liquid can emerge from the filtrate outlet. The opposite end of the static pan to the filtrate outlets forms a gentle slope. The vibrating mesh frame is supported within the static underpan in such a way that the liquid level is maintained about 1 in. above the mesh surface. The reject material is removed by a travelling brush which sweeps this reject material up the slope at the end of the mesh frame and thence to the reject outlet.

The submerged mesh principle was resorted to in the process mentioned above on account of the fact that on the ordinary separator the bag fluff fibres showed a tendency to staple into the mesh, but no such tendency was apparent when the submerged mesh principle was employed. A 40-mesh screen was used.

As will be seen from the foregoing many straining operations which hitherto have not been practical now become more than a possibility.

Another interesting machine is the new Russell Cascade Mark V Grading Machine, which makes possible sieving processes calling for classification into three grades. This has been achieved by fitting the top two mesh surfaces of the Cascade with a 40-mesh for the extraction of dust, the remainder of the material passing over a 20-mesh which separates the over-size particles so that three outlets of the machine yield respectively:

(a) The dust.
(b) The required product.
(c) The over-size material.

This machine has been used for the processing of a polymer used in the plastics industry, extracting the dust that will pass through a 40-mesh and rejecting particles too large to pass through a 20-mesh. It has also been used for the processing of a ceramic flux where the meshes employed were 40 and 60.

In addition to the new equipment, the standard range of Russell equipment was shown.

A NORTHERN ADVISORY SERVICE

TO meet the demands made on the "flexible" advisory service of Compoflex Co. Ltd. by industry in the Midlands and North of England the company has opened a Northern Flexible Centre at their factory in Huddersfield Road, Oldham.

The centre is staffed by a team of specialists able to give advice on the most suitable flexible tube or hose to use in any given situation. A development section has also been started in Oldham, to deal with the design of special flexibles for particular projects.

On walls of the new centre are large photographs representing each branch of industry, with the various flexibles used in that branch displayed beneath.

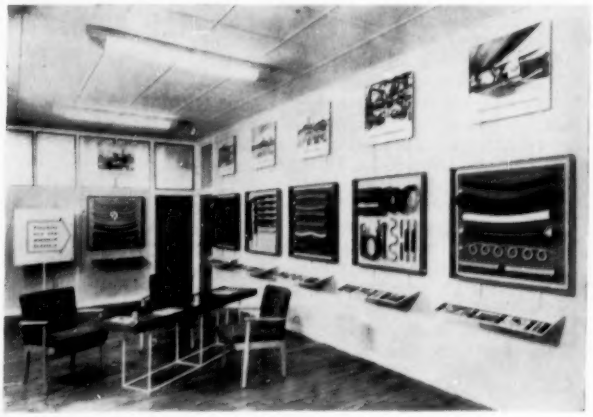
The first Flexible Centre was opened by Compoflex Co. Ltd. at their head office in London (26 Grosvenor Gardens) in 1952.

Since the war many new uses for flexibles have arisen, primarily through the establishment of new industries, the need for improved performance and the discovery of new chemicals and processes. The rapid developments in the plastics industry, and the consequent introduction of new materials, has had a very marked effect on the design of flexibles, and widens appreciably their fields of application.

Basically, the four main types of flexibles are rubber, metallic, plastics and composite, and it is in the last two fields that the greatest advancements are being made. Plastic tubes and hoses are, as yet, in a comparatively early stage of development but will, without doubt, play an ever increasing part in industry. Composite flexibles were practically unknown before the war, but the rubber shortage during the Japanese occupation of Malaya forced their rapid development. This type of flexible consists basically of one or more wire spirals used in conjunction with plastics, synthetic rubbers, canvas or natural rubber, etc.

It will be appreciated that thousands of different types of flexibles can be manufactured—the problem is to select the one most suitable for any given situation. No one manufacturer could ever produce all the types, or even a suitable flexible for every requirement, so that a potential user of flexibles is normally unable to get a complete picture of all the types available.

For this reason the company inaugurated the "Compoflex Service" a few years ago. This comprehensive advisory service is capable of dealing with all the problems connected with flexibles, and is in a position to offer unbiased advice to any potential user on the best type of flexible for his particular needs. The firm itself concentrated on producing those types of flexibles best suited to their manufacturing processes, but made arrangements with other manufacturers for the production of other types of flexibles to be made to specifications laid down by Compoflex.



The Northern Flexible Centre which has just been opened at Oldham has on its walls photographs representing each branch of industry

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NEW REFRACTORY MATERIALS

AFTER several years of experiment, Vincent Davis Glazes Ltd., of Stoke-on-Trent, announce the launching of a new range of refractory cements and surface seals. They have catered for the specialised requirements of the ceramic industry, and a series of prolonged tests have been carried out successfully at the works of associated companies and other manufacturers.

The range includes XIX/4, a snow-white surface seal, which is compounded to prevent disintegration of refractories, face hardening of insulating bricks, and to resist acid attack on kiln doors. XIX/4 can be applied by brushing, spraying or dipping and needs no stirring as the ingredients are milled and blended to give perfect suspension.

XIX/12 is the surface seal in cement form. This is a jointing medium for refractories on kiln trucks and in tunnel ovens, and by reason of its exceptional air-setting strength, it is claimed to be ideal for repairing broken bats and saggars.

XIX/17, another cement with a high tensile strength is used for fixing dots on to tile cranks, and it has already proved its value in preventing the unhappy affairs where displaced bungs cause a crash in the glost tunnel oven.

Vincent Davis Glazes Ltd., have given particular attention to the problem of glaze take up and have developed XIX/30, a glaze-repellent bat wash which it is claimed is simply applied and highly efficient in its field.

It is interesting to note that the XIX range is being extended to meet the high-temperature requirements of the steel industry. Both cements and seals are being used in the construction and protection of furnace doors and roofs, for slag dispersal, and as a protection against slag pocketing. Experimental work is also in progress at the company's London Road Works, Stoke-on-Trent, on special air-setting cements for the fixing of strain gauges on jet-turbine blades in the aircraft engine industry.

Fuller particulars are obtainable on request from the makers, Vincent Davis Glazes Ltd., who inform us that any temperature range can be catered for.

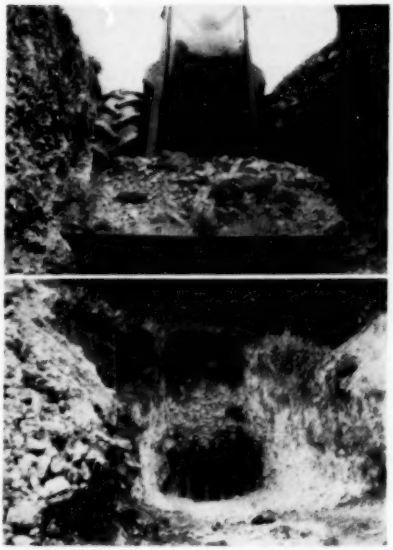
NEW BRITISH BULK LOADER

WHEN the new British bulk loader, the Matbro Super Loadstar, was designed, particular attention was paid to the need for a machine capable of handling all types of heavy and awkward loose bulk, sometimes under really bad conditions. The first test of the prototype of the Super Loadstar has satisfied the makers that, by departing from the usual British practice with loaders of the heavy class and giving the machine front-wheel drive, an unusually powerful loader has been developed.

A recent test has provided proof of the machine's exceptional power. In order to find out just how rugged the Super Loadstar was, an experiment which was expected to be a test to semi-destruction was carried out. The site selected for the test was flat virgin soil with a substratum of chalk. On this ground the "biting power" of the loader was put to the test.

The result was completely unexpected: it was found that the machine performed with comparative ease a task for which it was not designed and would not reasonably be expected to perform. When the experiment was abandoned the Super Loadstar, with no other assistance whatever, had excavated a hole through the earth and chalk measuring 45 ft. long and 15 ft. deep. The loader was none the worse for its exertions, a hole in the replaceable mica windshield being the only damage suffered.

The Super Loadstar is powered by the 40 h.p. Fordson Major engine with six forward and two reverse speed transmission and the bucket and arms are hydraulically controlled. The makers are Mathew Brothers, Sandy Lane North, Wallington, Surrey.



Above: The new front-wheel drive British bulk loader backing out of the vast hole which it had excavated in flat virgin soil with chalk sub-strata. The test did little damage to the machine. Below: The size of the hole (15 ft. deep; 45 ft. long) is well illustrated here

NEW BULK STORAGE WALLS

AN attempt to solve the difficult industrial problem of bulk storage has led to the manufacture of Marley Storage Walls. It is claimed that they can treble the capacity of a site considered inadequate or alternatively save valuable space by concentrating storage in a smaller area. The difficulties experienced in "dump" storing, stocktaking, cleaning and wastage are removed. In addition, valuable materials are protected from theft.

The walls are made from high-grade reinforced concrete. They are supplied in standard size units 7 ft. high × 2 ft. wide, and two types are available. One is designed to hold materials reposing at an angle of 35° at maximum loading pressure up to 50 lb. per cu. ft. These include coal, coke, solid fuels, slag and ashes. The second type—also suitable for use as retaining walls and loading platforms—is intended for pressure up to 100 lb. per cu. ft. Materials in this category are sand, gravel, granite, chips, lime, crushed stone, cement and minerals.

Pressure on the wall units is governed by the density of materials and the degree to which they are self-supporting, factors to be considered when choosing the type to use. Special units with metal straps to give additional support at the corners can be supplied for 90° angles and intersections. Radius units with a 10° mitre are available for curved sites. The walls are adequately holed for lifting purposes and for the attachment of any special metal fittings, such as angle iron extensions, carrying lines of barbed wire or gate-post brackets.

The units, for use indoors or outside, are designed for erection on a level surface. Although storage areas can be planned economically, alterations in layout can be made at any time. As the walls are not fixed to the ground or each other, they can be dismantled and re-erected elsewhere if necessary. They can be loaded against either side or both. Rust, rot and frost-proof, they require absolutely no maintenance.

The British Ceramic Society

WE give below abstracts of the papers appearing in the *Transactions* of the British Ceramic Society for October, 1954.

Symposium on Casting-pit Refractories

1. A Statistical Investigation into Factors Affecting the Life of Ladle Linings, by J. E. Andrew.

The papers deal principally with the effect of several steelmaking variables on lining life. It is outlined in the introduction, however, that two methods of analysis are available, the more exact involving an assessment of the brick wear caused by each cast during a life. Section 1 of the statistical analysis of data is mainly concerned with estimating the accuracy of the dip-stick reading which, together with the ingot weight, can be used to measure the maximum capacity of the ladle for each cast, and hence the wear as life proceeds.

It is shown that the dip-stick measurement errors were too high for the detailed analysis proposed. Further work revealed that the capacity of the ladles, even when first put into service, was about 11 steel tons in excess of the average weight of steel held. Estimates of wear showed that, at the end of a lining life, about one-third of the brickwork had been lost.

Section 2 of the statistical analysis shows that the bricks from different makers were not equally good, and that the shape of the ladle appeared to affect life. The effects upon life of the percentage of carbon and of tap iron, the time from tap to finish teem and the slag depth were determined, and the difference in life between ladle shapes was accounted for by the different slag depths carried.

As a result of the analysis, several recommendations can be put forward for improving lining life, the most attractive of these being a reduction of the slag depth. Because of the large amount of slag present, a decreased teeming time, particularly in the after-casting period, would also be beneficial. Rather high variations in the tapped weight appear to be the fundamental reason for carrying 7½ tons of slag on the average cast.

2. Steel-Ladle Trials on Fireclay Bricks, by H. R. Lahr.

The split-ladle technique—the lining of a ladle with two or more different types of bricks—affords a quick and reliable method of determining the order of merit of different brands of ladle bricks under practical conditions in the steelworks. This method of testing was applied to thirteen different brands of fireclay bricks ranging from 29-43 per cent. Al_2O_3, and observations were made of over 100 ladle linings at two steel plants. The usual laboratory tests were carried out on twenty bricks of each make. From the work carried out, it can be stated that the physical properties of a ladle brick—i.e., dense texture, low porosity and high-firing temperature to induce vitrification—are far more important than the $SiO_2 : Al_2O_3$ ratio. If high refractoriness can be associated with high density, as in the case of a 43 per cent. Al_2O_3 brick which had an average apparent porosity of 10 per cent., an additional advantage may be conferred by the chemical composition.

3. Performance of Continental Ladle and Runner Bricks, by G. Van Gijn.

The effect of operating conditions, which so strongly affect the life of casting-pit refractories, is well illustrated by variation in the life of ladle linings.

For given operating conditions, differences in ladle-lining life cannot be explained by the results of laboratory tests, since bricks having apparently the same properties behaved quite differently, and vice versa.

Micro-examination in reflected light has shown that differences in behaviour can be explained when the heterogeneity of casting-pit materials is taken into account, whereas the standard laboratory tests give results that represent the properties of a brick as a whole.

For instance, aluminous ladle bricks with a low-refractory high-alkaline matrix have been readily attacked by slag, whereas less aluminous ladle bricks with a more refractory matrix have shown no penetration by slag, in spite of their much higher porosity. The same applies to runner bricks.

Attacking problems from this—topoceramic—point of view has proved valuable in developing refractory materials with improved resistance to slag attack.

4. A Laboratory Test for the Assessment of Ladle Bricks, by J. Mackenzie.

The interpretation of standard refractory tests on fireclay ladle bricks is difficult and the correlation of properties with performance is extremely compli-

cated. The high expenditure on ladle refractories in some steel plants gave rise to a detailed laboratory investigation of standard properties, together with a new test in which an attempt was made to simulate service conditions by immersing a sample of the ladle brick in molten steel with a liquid basic slag on top. These dip tests were carried out at 1,600° C. on high-alumina and siliceous ladle bricks. Based on a visual estimate of cut at the slag line and penetration of slag and metal into the brick, an order of merit table was drawn up.

There was a general indication that a high dip index was associated with good ladle performance in the plant. Difficulty was, however, encountered in interpreting the results with bloating bricks, since bloating did take place in the dip test whereas it has been concluded that, apart from some bloating to seal joints, excessive bloating does not take place in a ladle in service.

In concluding with recommendations for ladle bricks, the importance of good shape and size and freedom from black heart is emphasised. High density and a true porosity no higher than 15 per cent., irrespective of the thermal shock resistance, are favoured by the author. Some after-expansion tendency is thought desirable, but the necessity for extremely high bloating on reheating is doubted.

Experiments with Firebrick Batch for Dry-Pressing, by J. M. McWilliam and J. McM. Gilmour.

The merits of high-grade dry-pressed firebricks and a method employed to investigate means of improving certain of their properties are examined. Data on the high-temperature behaviour of a range of dry-pressed firebricks indicate that high density and coarse texture give the best performance. The effect of various additives on the green and fired strength has been investigated. The application of "work" mulling to dry-pressed firebrick batch has been studied on laboratory and works scale. The distribution of water in a batch so treated is more uniform than had been obtained previously, and mulling improves flowing and packing properties of the batch. Mulled batch can stand a higher forming pressure than the same untreated batch and the green and fired properties are better. The changes in grading undergone by the batch during mulling and pressing are commented upon.

QUICKFIT & QUARTZ BOARD CHANGES

CHANGES on the Board of Quickfit and Quartz Ltd., manufacturers of laboratory glassware and glass industrial plant, of Stone (Staffs.), are announced by Sir Graham Cunningham, chairman and managing director of Quickfit and Quartz and of the parent Triplex group.

Lord Stanmore (83), has resigned on the grounds of age, having been a director of Quickfit and Quartz since 1946. Lord Stanmore resigned from the Board of the Triplex Safety Glass Co. Ltd., two years ago. Mr. Brian H. Turpin and Mr. Arthur Cochrane have also offered their resignations. Mr. Turpin is managing director of the Quickfit and Quartz subsidiary, Q.V.F. Ltd., and Mr. Cochrane is assistant managing director of the Triplex Safety Glass Co. Ltd.

Accordingly, the Board have, with effect from 1st January, 1955, co-opted as directors Mr. D. Curtis, the firm's development manager, Mr. E. L. Harrison, sales manager, and Mr. E. S. Pearse, works manager.

Donald Curtis (44), joined Quickfit and Quartz in 1938. Edward Lawrence Harrison (38), joined the firm in 1935 and Edward Sainthill Pearse (47), has been works manager at the Stone factory of Quickfit and Quartz since 1950.

Fifth member of the Quickfit and Quartz Board is Mr. J. D. Nuttall, secretary of Triplex.

In the director's report for the year ended 30th June, 1954, Sir Graham reported a profit of £18,531 for Quickfit and Quartz, which paid its first dividend on the Ordinary shares—20 per cent. less tax, previous profits having been retained to strengthen the company.

Old Custom Revived.—An old custom was revived during Christmas week when "yards of ale" were quaffed by the glassblowers at the Whitefriars glassworks of James Powell and Sons Ltd., Wealdstone.

Before the price of beer made the practice too expensive, glassblowers—who work in intense heat—drank beer at regular intervals to quench their thirst. A boy was charged with the full-time job of bringing supplies, carried in cans on a pole slung across his shoulders. In recent years, however, water has been substituted. Learning of the old-time custom, Charrington's generously provided the necessary beer to revive it, at least for one day, at Christmastime. The glassblowers drank a Christmas toast from "yards of ale," crystal goblets and other vessels of their own manufacture.

BOOK REVIEWS

Dresden China, by W. B. Honey. Faber and Faber Ltd., 30s.

The serious student of ceramic art should be well pleased that Faber and Faber have brought out a new edition of Mr. Honey's well-known work on Dresden china. Not only the specialist, however, should derive satisfaction from reading this book since it contains a fascinating and simple, yet scholarly, description of the exciting story of the rediscovery in Europe of the process of porcelain manufacture, long practised by the Chinese. Mr. Honey traces the development of the industry from its establishment at Meissen in 1710 until recent times. The bulk of the work, however, is concerned with the eighteenth century—the great age of Dresden china.

Mr. Honey's taste in such matters as early European porcelain is indisputable, and it is a rare privilege to be allowed to wander with him through the crowded pages of Dresden history, examining its porcelain piece by piece, assessing the qualities of this or that modeller, and comparing the skill of the factory and the independent decorators, the *Hausmaler*.

As an introduction to Dresden china this book has no equal. Well illustrated, with full notes and bibliography, there is little to be desired. It is a pity that more of the illustrations could not have been in colour since a black and white reproduction gives only a faint impression of the artistry of the craftsmanship; but that is only a small criticism. We welcome the reappearance of this scholarly work.

Oriental Blue and White, by Sir Harry Garner. Faber and Faber Ltd., 30s.

A remarkably concise but beautifully illustrated book has just been published by Faber and Faber on the celebrated "blue and white" period of oriental art, the finest period of which is Ming. Ming china is known to everyone by repute, though there are relatively few who are able to identify it at sight. Sir Henry Garner is one who in his leisure hours has got to know it intimately. In this book he imparts some of his knowledge to us and traces the development of "blue and white" from its early days in the fourteenth century to the seventeenth century and beyond. In the course of time as a result of increased Chinese exports "blue and white" china became fashionable throughout the civilised world and many European potteries began manufacturing it. This fashion persists and more than one British firm continues to turn out eighteenth-century designs which derived inspiration from oriental pieces.

Sir Henry Garner has given us only a brief guide to oriental "blue and white" but he has whetted our appetites for more. The illustrations, several of which are in colour, help to confirm our feelings that we know all too little about Chinese ceramic art.

The Decoration of English Porcelain, by Stanley W. Fisher, F.R.S.A. Verschoyle, 42s.

The recent period of austerity led to a great demand for earthenware, especially from the studio and art potteries. Naturally the porcelain trade was bound to suffer, the more so because so many of the pieces manufactured were for "export only." Now, however, there is a far greater variety of choice, and porcelain of a high decorative quality is once more obtainable. In view of this fact Mr. Fisher's book on English porcelain decoration is doubly welcome since it not only serves as a reminder of what we have been missing but also acts as a spur to encourage us to take up, so far as our purses will allow, the delightful habit of collecting.

Mr. Fisher's treatment of his subject is very comprehensive and we are enabled with his aid, to follow the evolution of an English style from early beginnings. Flower and Fruit Painting, Bird Painting, Figure Painting and Landscape Painting are each the subject of a chapter as are other styles of decoration. There are also well chosen illustrations of beautifully decorated pieces which can only be described as highly eligible for a place in the collector's cabinet.

The book is deilghtfully produced and fully merits a place on the serious collectors' bookshelves.

Porcelain Through the Ages, by George Savage. Penguin Books, 5s.

A handy little book, the first inexpensive history of porcelain to be produced, has just been published in the Pelican series. Its author, Mr. George Savage, well known for his books *Ceramics for the Collector* and *Eighteenth-century English Porcelain* has attempted in this book to give a potted history of the growth of the porcelain industry not only in Europe but also in the Far East. Inevitably with a book of this size (352

pages) there are bound to be differences of opinion concerning the allotment of space to the history of the industry in different countries but on the whole the allocation is fair. Perhaps more could have been written about Germany and Austria where the European porcelain industry was started.

Of most value to the would-be student of porcelain is the introductory essay in which the methods of manufacture and the differences of styles are discussed. At the end of the book there are also identification marks which, not being exhaustive, may perhaps lead to some wishful thinking but are valuable none the less. A very useful bibliography is appended. In addition there are 64 pages of illustrations which go a long way towards illustrating the points made by Mr. Savage in the text. However, as he himself admits in the preface, the number "ought to be multiplied by many times."

This is a worthy Penguin book and fills a gap in the series. Those interested in porcelain would be well advised to read it.

Co.I.D. POTTERY COURSE

WHOLESALE as well as retail salesmen have been invited to attend the Council of Industrial Design's next pottery course, to be held at the Wedgwood Memorial College, Barlaston, Stoke-on-Trent, from 21st-25th February. Much of the pottery marketed in this country is sold through small general or hardware stores, which handle a variety of other goods; these retailers are often entirely dependent on their wholesalers for the choice of stock. The Co.I.D. Pottery Course is, therefore, of value for the wholesale salesman on two scores. It provides an opportunity for him to take part in trade discussions with those who sell to the public, and will widen his knowledge of new developments in pottery design, thus helping him to become an ambassador of new ideas to many retailers.

The inclusive charge is 10 gns. Applications should be made as soon as possible to the Retail Officer, Co.I.D., Tilbury House, Petty France, London, S.W.1.

BRITISH PRODUCTIVITY COUNCIL

AT the annual general meeting of the British Productivity Council, held on Wednesday, 15th December, 1954, Mr. Tom Williamson, C.B.E., J.P., general secretary of the National Union of General and Municipal Workers, concluded his year of office as chairman of the Council, and was succeeded by Sir Ewart Smith, technical director of Imperial Chemical Industries, who has been deputy chairman for the past year. Mr. J. Crawford, J.P., general president of the National Union of Boot and Shoe Operatives, Member of the General Council of the Trades Union Congress and chairman of the T.U.C. Production Committee, was elected deputy chairman.

Tribute from all sides was paid to the work of Mr. Williamson during the year. He will continue to be associated with the work of the B.P.C. as a member of the Council.

Sir Ewart Smith, who succeeds him, has been active in the work of the Council since it was set up. His company is well known in connection with the development of productivity techniques and for making its experience in this field available to industry generally.

Four members of the Council retired—Sir Cuthbert Clegg and Mr. A. G. Stewart, of the British Employers' Confederation, and Sir William Lawther and Mr. Jack Tanner of the Trades Union Congress. Five new members were elected—Mr. G. Pollock, Q.C., director, British Employers' Confederation; Mr. W. T. Winterbottom, O.B.E., vice-president, B.E.C., and chairman, Fine Spinners and Doublers Ltd.; Mr. H. Collison, general secretary, National Union of Agricultural Workers; Mr. W. E. Jones, O.B.E., president, National Union of Mineworkers, and Mr. R. Openshaw, general president, Amalgamated Engineering Union.

Sir Ewart Smith, on his election as chairman of the British Productivity Council, said:

"The work of the Council has made good progress during the year and in particular the increase in numbers of Local Productivity Committees to a total of ninety-six has been most encouraging. In these bodies, as on the Council itself, the employers and trade unionists came together for the common purpose of improving productive efficiency. The objective is to strengthen the whole economy so that all may benefit. Developments during the past year support the idea that this work is indeed playing a very effective part in achieving the industrial advance which is now taking place."

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BRITISH TITAN PRODUCTS CO. LTD., has a vacancy for a male GLASS/CERAMIC/ENAMEL TECHNOLOGIST for applied Research in its Technical Sales Service Department at Billingham, County Durham. Whilst academic qualifications of degree standard would be desirable nevertheless consideration would be given equally to unqualified Technologists with practical or industrial experience. Applicants should preferably be under thirty-five years of age. Conditions of work and service are very attractive and there are Staff Bonus and Superannuation Schemes and non-contributory Life Insurance cover. Commencing salary dependent on age, qualifications and experience. Application forms may be obtained from the Personnel Manager, British Titan Products Co. Ltd., Coppergate, York, quoting reference S.18P.

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This is an Arrow Press Publication. Published Monthly.
Subscription Rate 25s. per annum.
Published by Arrow Press Ltd. at 157 Hagden Lane, Watford, Herts.
Telegrams: "Techpress, Watford." Telephone: Gadebrook 2308/9.

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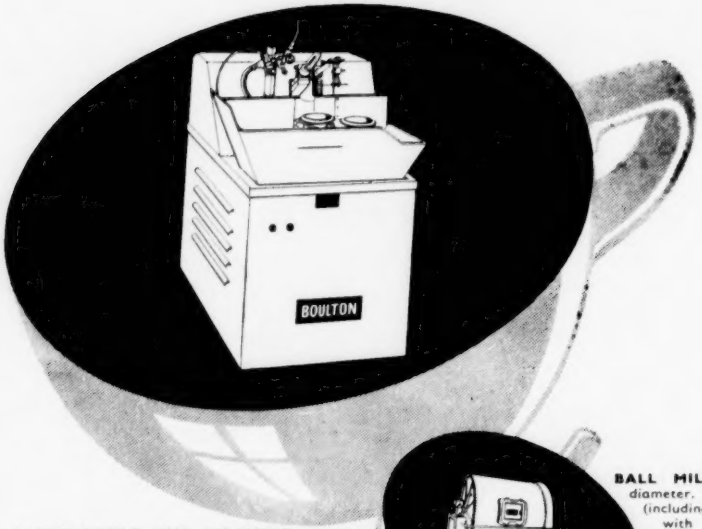

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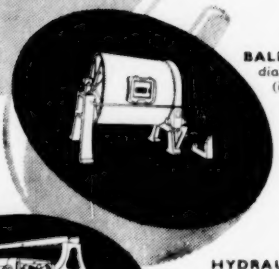

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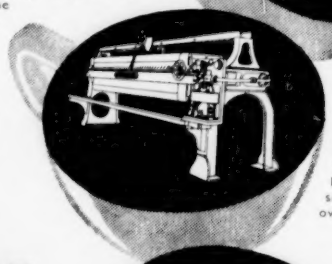

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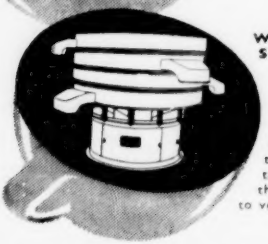

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